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MARINE ENGINEERING.

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DESCRIPTION OF THE STEAM YACHT ELLIDE AND HER SPEED TRIALS.

BY W. F. DURAND.

The steam yacht Ellide, designed by C. D. Mosher for E. Burgess Warren, of Philadelphia, has shown on trial such an unprecedented speed that a description of the boat and machinery and of her trials should be of great interest to all who are concerned with the advance of marine construction, and especially with the development of the highest attainable speeds on the minimum of size and weight. Through the kindness of Mr. Mosher, the author has been given access to this data in order that the results may be placed before those for whom they would naturally have this high interest.

Description of Boat.

The Ellide is 80 ft. long, 8 ft. 4 in. maximum beam, and, aside from the propeller, has a draft of about 2 ft. The normal displacement is about 13 tons. The boat is of composite construction, and is sub-divided by five steel bulkheads into six water tight compartments. The planking is of double skin mahogany, and all the fastenings are Tobin bronze bolts.

STEAM YACHT ELLIDE, DOING 27.3 MILES PER HOUR ON THE MEASURED MILE.

The accommodations shown in the plans on page 2 consist of a large cock-pit forward, fitted with steering wheel, compass and binnacle, speaking tubes and annunciators. Seats are also fitted on either side with drawers and lockers underneath.

Next abaft on the port side is a large ice chest and china closet, while on the starboard

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side is a toilet room with the usual fittings. Next abaft is the machinery space, aft of which is a dining room 18 ft. long provided with seats and drawers underneath, an extension table at the forward end, a pantry, suitable buffets, lockers, etc.

The forward and after decks are fitted with a bronze railing, while all the usual deck fittings, including the stack, are of polished brass. A permanent wooden awning is supported on brass stanchions, and glass windows are fitted so as to enclose at will the forward and after compartments. A light 13 ft. boat is carried on davits.

Machinery.

There is one Mosher patent quadruple-expansion engine, having cylinders 9 in., 13 in., 18 in. and 24 in. dia., by 10-in. stroke. All the cylinders are fitted with piston valves and have relief valves on both their upper and lower heads. The steam chests are fitted with automatic by-pass valves. The cylinders are not steam jacketed, but are well lagged with magnesia and encased in a polished brass casing with spun heads.

The valves are worked by an independent valve crank shaft parallel to the main shaft, and so geared to it by double helical gears as to make an equal number of revolutions with the main shaft. Reversing is accomplished in the usual way by a spiral sleeve actuated by a reverse lever at the forward end of the engine.

All the material used in the construction of the engine is of the highest class. The main parts of the engine are of steel forgings, oil tempered and bored out hollow, and all the usual fittings are supplied in accordance with advanced engineering practice. The engine as erected in the shop is shown in the engraving on page 3.

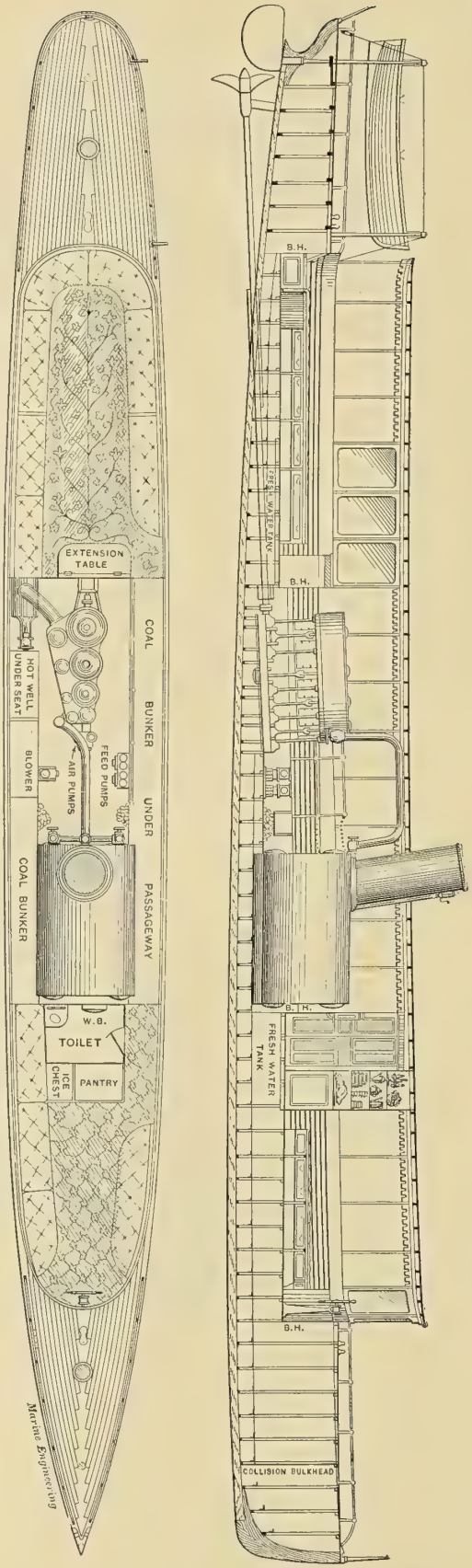
The propeller is 40 in. in dia. and of about 60 in. mean pitch.

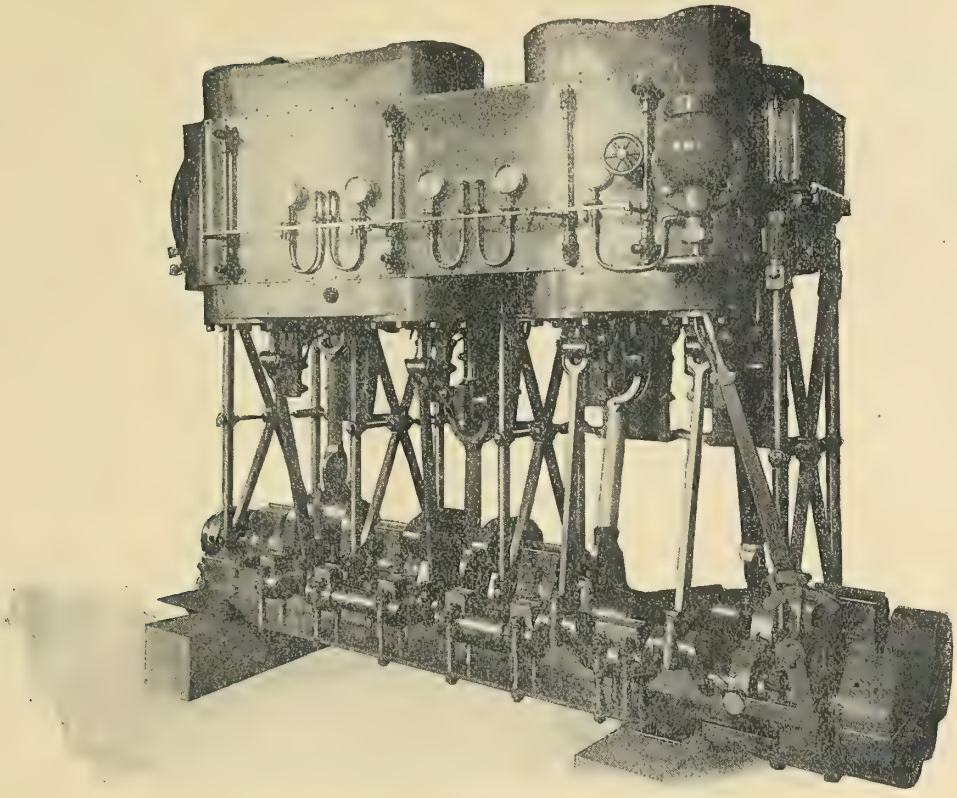
In addition to the main propelling engine there is an inboard surface condenser, and six specially designed auxiliaries, including feed-pumps, air-pumps, circulating-pump, bilge-pump and blower. The latter supplies air to the furnaces on the closed ash-pit system.

The boiler (illustrated on page 3) is of the Mosher Water Tube type, encased in polished brass. It consists of two steam drums placed over two water drums and connected together by a number of solid drawn steel tubes, so arranged that the gases pass twice the length of the boiler at right angles to the tubes before entering the stack, thus absorbing a high proportion of the heat liberated, and giving to the boiler a high efficiency. Each side of the boiler is practically independent, although the furnace is common to both.

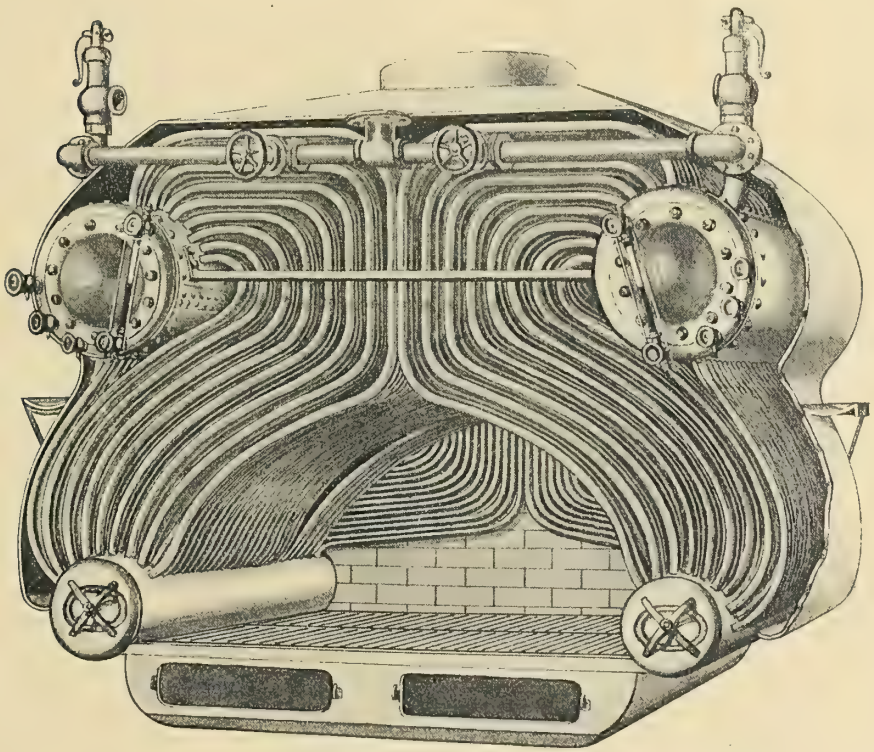
The boiler has 1,203 square ft. of heating surface and 30 square ft. of grate surface, and is similar to those now in use in nine of the torpedo boats of the U. S. Navy.

ACCOMMODATION PLANS OF THE SINGLE-SCREW STEAM YACHT ELLIDE, DESIGNED BY CHARLES D. MOSHER FOR E. B. WARREN, PHILA.





QUADRUPLE-EXPANSION ENGINE OF STEAM YACHT ELLIDE.



MOSHER WATER-TUBE BOILER OF STEAM YACHT ELLIDE.

Speed Trials on the Hudson.

The trials were carried out over the statute mile course of 5,280 ft., recently laid off by the U. S. Coast Survey steamer A. D. Bache, on a straight line, off Irvington-on-Hudson. The ends of the course were marked by range poles

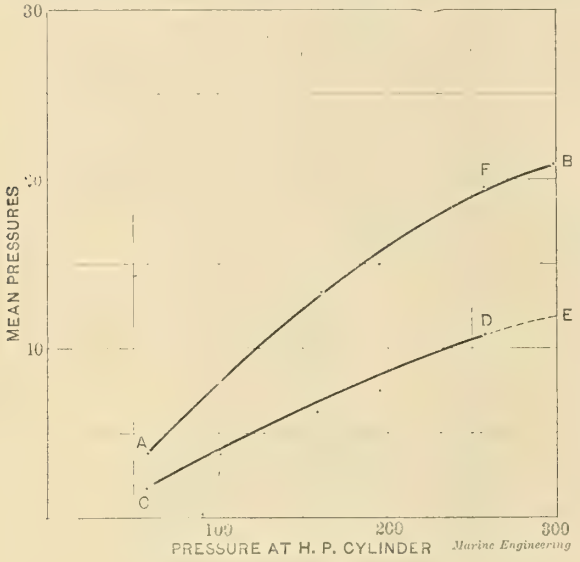


FIG. A.

on the river bank at right angles to the course. On each run the speed of the boat was adjusted by the throttle valve and the steam pressure maintained as nearly uniform as possible. The judges in the forward cock-pit took the time

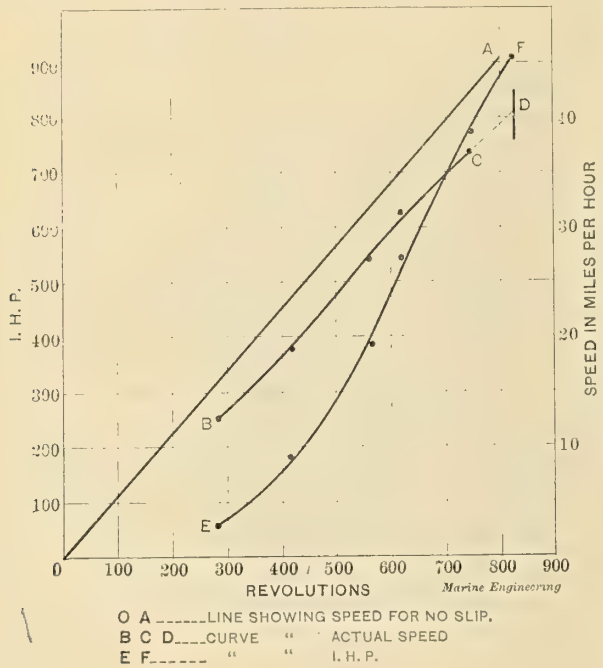

I. H. P.
REVOLUTIONS
SPEED IN MILES PER HOUR
Marine Engineering
O A ------LINE SHOWING SPEED FOR NO SLIP.
B C D----CURVE " ACTUAL SPEED
E F------ " " I. H. P.

FIG. B.

with stop watches, and by a single stroke of the bell at the beginning of the mile signaled the engine room, where indicator cards were taken, and the steam pressure and revolutions were recorded. On each of the runs over the course, indicator cards were taken from each of the cylinders, and the revolutions were taken by a special speed indicator connected to the shaft of the engine. The indicators used were specially designed by Mr. Mosher for extreme high

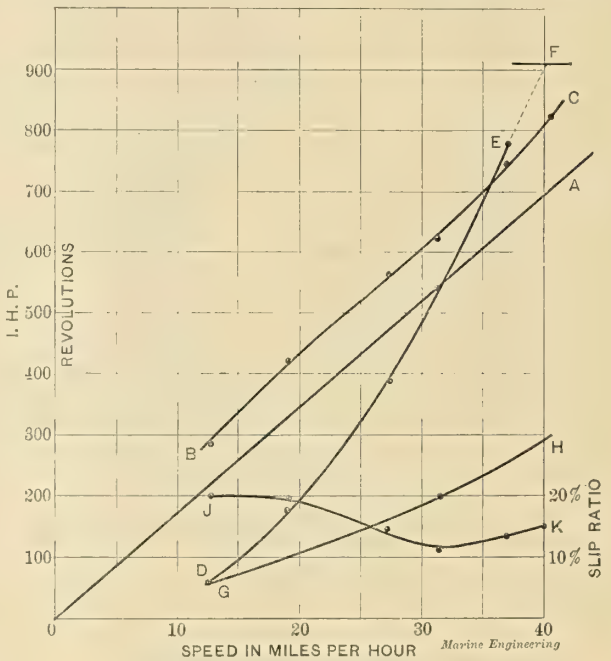

I. H. P.
REVOLUTIONS
SLIP RATIO
20%
10%
SPEED IN MILES PER HOUR
Marine Engineering
O A -----LINE SHOWING REVOLUTIONS FOR NO SLIP.
B C-----CURVE " ACTUAL REVOLUTIONS.
D E F--- " " I. H. P
G H----- " " STEAM PRESSURE AT H. P. CYLINDER.
J K---- " " VALUES OF SLIP RATIO.

FIG. C.

speeds, and were made under his direction by the Crosby Steam Gauge Co.

A selection of the cards taken is shown on page 6, together with the steam pressures, revolutions and other data relating to the power. It is proper to state, however, that all of the cards here reproduced were not taken on the same date, though the load on the boat and other conditions were practically the same on all the trials. The actual length of the original indicator cards is about 1 1-2 inches, this small size being necessary in order, at the high revolu-

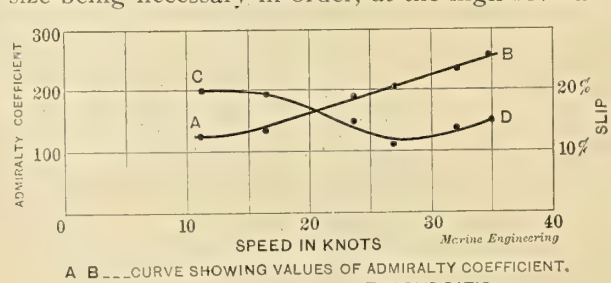


FIG. D.

tions, to avoid undue effects due to the inertia of the indicator drum.

The appearance of the boat in the water and the nature of the wave disturbance is shown in

the several engravings on pages 1 and 7 showing the results for varying speeds from medium to the highest attained. Due to the form of the boat the entrance lines become finer and finer as the bow continues to rise out of water, while due to the breadth and form at the stern there is no settling or squatting at any speed. It further follows that as the bow rises the run or buttock lines continue to become more nearly horizontal, so that at the highest speeds the after body is in large part simply sliding along nearly parallel to the surface of the water.

Discussion of Results.

Of the various indicator cards taken, all are apparently well formed and correspond to normal conditions, with the exception of one, the L. P. card, at the highest speed. There was evidence of water in the cylinder at the time this card was taken, and its influence is plainly shown in the form of the card with diminished area and rounded corners. In order, therefore, to obtain the I. H. P. at this speed it becomes necessary to apply a correction to this card, so as to obtain as nearly as possible the mean effective pressure which would have been obtained without water in the cylinder. To this end we have plotted in Fig. A the series of mean effective pressures from the second intermediate cards, on the H. P. valve chest pressures as abscissæ. This gives the curve A B. We next plot similarly the mean effective pressures from the L P cards, omitting that for the highest speed. This gives the curve C D. Now, extending this curve according to the general law shown by both A B and C D we find a point E which must be very near the correct value for 300 lbs. pressure at the engine. The value thus indicated is about 11.8 lbs. If we should make a proportion between the pressures at 257 and 300 lbs. for these two cylinders we should have:

$$19.37 : 20.88 : : 10.78 : x$$

This gives $x = 11.6$ lbs. a value very near the one obtained graphically. Presumably the value 11.8 is the more reliable of the two, however, because it results from a curve which takes account of the whole general trend of the pressures, while the value 11.6 results from the use of the data at 257 and 300 lbs. only. The difference is really insignificant, and either value would doubtless be quite near the true one. In any event we may be sure that some such value is the best that can be determined from the data in its existing condition. Using, then, the value 11.8 for the L P card at this speed we derive for the I. H. P. in this cylinder 223, and for the total I. H. P. 910.

Next, with regard to the speed data we find a further deficit in the absence of the speed for this power. This was due to a momentary derangement of some of the auxiliary machinery just before the runs were completed, causing the loss of the speed data at this power. Both revolutions and indicator cards were, however, taken, and by a proper use of the results as a whole the deficit may practically be made good. This may be accomplished in several ways.

In Fig. B O A gives the relation between speed and revolutions for no slip. B C gives the relation between actual speed and revolutions so far as completely determined. For the last condition we know simply that the revolutions were 822, and extending the curve B C, taking account of its general trend, we find a point D indicating a speed of slightly over 40 miles per hour, as corresponding to 822 revolutions per minute. In this diagram E F gives the I. H. P. plotted also on revolutions as abscissæ.

Again, taking the values of the I. H. P. and plotting them on the observed speeds, we have the curve D E, Fig. C. Taking the highest value of the I. H. P. as 910, and extending the curve in accordance with its general trend, we find similarly a point F, indicating also a speed of 40 miles, or slightly over, as the value corresponding to 910 I. H. P.

Both of these methods indicate substantially the same results, and it would appear that with reasonable assurance we may take the higher speed as 40 miles or 34.73 knots, and the others as observed.

In Fig. D we have plotted on speed in knots as abscissa, the values of the slip ratio and of the Admiralty co-efficient. The latter is derived from the equation:

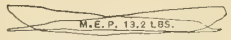
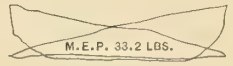
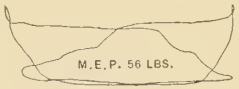
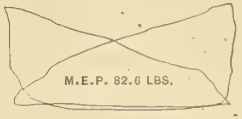
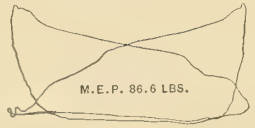
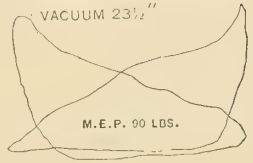
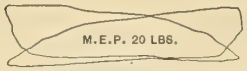
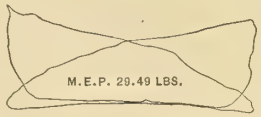
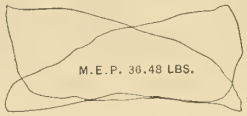
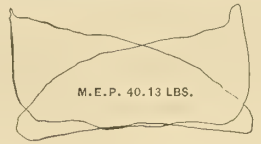
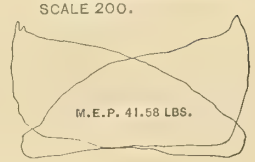
$$K = \frac{D^{2/3}\, v^3}{I.H.P.}$$

D being the displacement in tons and v being the speed in knots.

These valves, as determined, steadily increase from the lowest to the highest speeds. The lowest values are smaller than we might expect, while for higher speeds the values are correspondingly larger. The explanation of these peculiarities is perhaps to be found in the fact that the final results were attained after trying six different propellers, the one finally selected proving itself superior for the highest speeds, but relatively inferior for the lower speeds. We may therefore assume a condition of relatively low propulsive efficiency at the lower speeds, rising continuously as the speeds increase, with a corresponding decrease in the I. H. P. required relative to the cube of the speed, and a corresponding increase in the value of the coefficient K. It may also be observed that the indicator has of late years been suspected of under indicating the pressures at excessively high revolutions, and of thus giving a lower power than may really be required.* This would also tend in the same general direction, and the combined effect of these tendencies may serve to account, at least in part, for the values of K as determined. Also the lifting of the boat bodily from the water at these extreme speeds, and the consequent decrease of displacement and wetted surface, doubt-

* See Journal American Society Naval Engineers, 1895, p. 715.

INDICATOR DIAGRAMS FROM QUADRUPLE-EXPANSION ENGINE OF THE STEAM YACHT ELLIDE.

RUN No. 1	RUN No. 2	RUN No. 3	RUN No. 4	RUN No. 5	RUN No. 6
BOILER PRES. 160 LBS. REVOLUTIONS 285 VACUUM 21½″	BOILER PRES. 165 LBS. REVOLUTIONS 418 VACUUM 23″	BOILER PRES. 180 LBS. REVOLUTIONS 560 VACUUM 23″	BOILER PRES. 285 LBS. REVOLUTIONS 620 VACUUM 23″	BOILER PRES. 320 LBS. REVOLUTIONS 748 VACUUM 23½″	BOILER PRES. 390 LBS. REVOLUTIONS 822 VACUUM 23½″
					
HIGH PRES. CARD. HORSE-POWER 15.75 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 44.58 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 100.75 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 164.54 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 208.12 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 237.69 SCALE 200.
					
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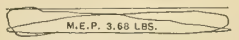
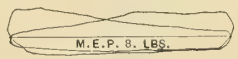
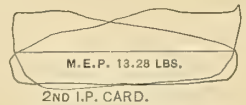
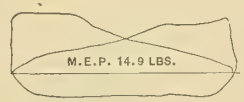
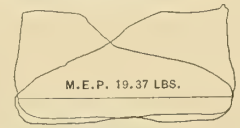
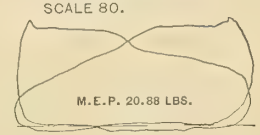
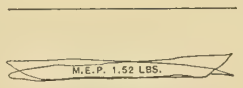
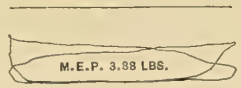
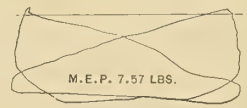
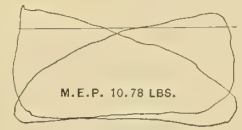
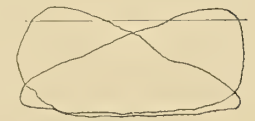
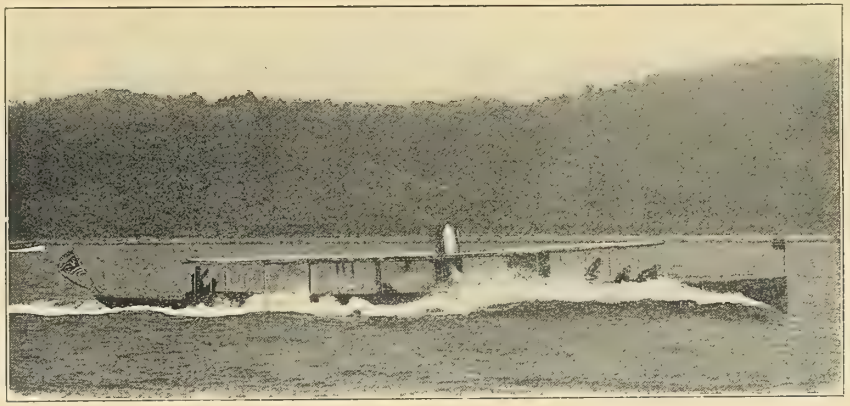
					
2ND I.P. CARD. HORSE-POWER 13.47 SCALE 40.	2ND I.P. CARD. HORSE-POWER 43.97 SCALE 40.	2ND I.P. CARD. HORSE-POWER 95.54 SCALE 40.	2ND I.P. CARD. HORSE-POWER 118.78 SCALE 40.	2ND I.P. CARD. HORSE-POWER 186.22 SCALE 40.	2ND I.P. CARD. HORSE-POWER 220.69 SCALE 40.
					
LOW PRES. CARD. HORSE-POWER 9.89 SCALE 20. TOTAL H.P. 58.19 SPEED 12.7 MILES.	LOW PRES. CARD. HORSE-POWER 35.03 SCALE 20. TOTAL H.P. 179.62 SPEED 19.05 MILES.	LOW PRES. CARD. HORSE-POWER 78.97 SCALE 20. TOTAL H.P. 386. SPEED 27.3 MILES.	LOW PRES. CARD. HORSE-POWER 107.63 SCALE 20. TOTAL H.P. 542.56 SPEED 31.2 MILES.	LOW PRES. CARD. HORSE POWER 183.36 SCALE 20. TOTAL H.P. 778.93 SPEED 37. MILES.	LOW PRES. CARD. SCALE 20.

Marine Engineering

FOR INSTANTANEOUS PHOTOGRAPHS OF THE STEAM YACHT ELLIDE TAKEN AT CORRESPONDING SPEEDS SEE OPPOSITE PAGE.

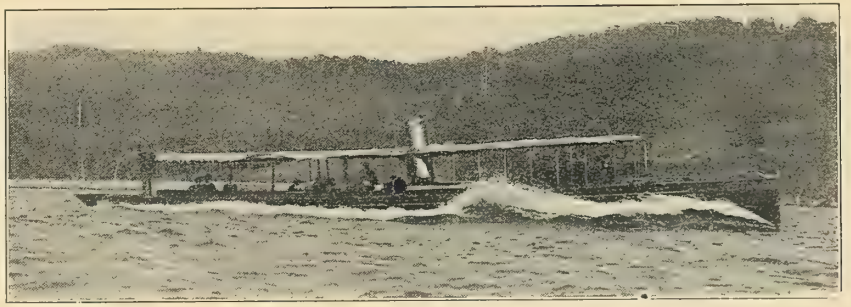
RUN NO. 1.—SPEED 12.7 MILES.

RUN NO. 2.—SPEED 19.05 MILES.



RUN NO. 6.—SPEED 40 MILES.

RUN NO. 4.—SPEED 31.2 MILES.



RUN NO. 5.—SPEED 37 MILES.

INSTANTANEOUS PHOTOGRAPHS OF THE STEAM YACHT ELLIDE GOING OVER THE MEASURED MILE ON THE HUDSON.—TAKEN BY JOHNSTON, N.Y.

less decrease relatively the resistance and power required, so that we have here an additional reason for the relatively high values of the coefficient under these extreme conditions. Similar results have been found for many recent high speed boats, so that the tendency toward a relatively high efficiency under extreme conditions (at least as measured by the steam engine indicator) may be considered as entirely normal, and as a result naturally arising from the interaction of all the special features going to make up the condition as a whole.

In connection with the results for the Ellide the data given in the table on this page relating to several recent fast boats of various types, as given in the published accounts of their trials, may be found of interest. The relation of a boat to the wave formation about it, and to the general problem of resistance and propulsion is usually considered to be the same for similar forms at corresponding speeds, or at speeds in the ratio of the square roots of the lengths. As a problem in propulsion, therefore, it becomes more and more difficult to attain high speeds, and requires a continually increasing proportion of I. H. P. to displacement, as the length and displacement are smaller. As showing, therefore, the relation of these various results to the general problem of propulsion, a comparison may be made of the various speeds all reduced to the "corresponding" speeds for a standard length, as, for example, 100 ft. These speeds are given in the next to the last column of the table.

In conclusion, the writer would state that he had on one occasion the pleasure of being on board during trials of the Ellide, and while on that occasion the roughness of the water made it inadvisable to run the boat at the highest speeds, yet the ease and moderate steam pressure with which speeds up to about 30 miles per hour were attained, furnished every evidence of abundant capacity to do all that the trials herein reported seem to indicate.

PERFORMANCES OF VARIOUS HIGH SPEED BOATS REDUCED TO A COMMON BASIS OF COMPARISON.

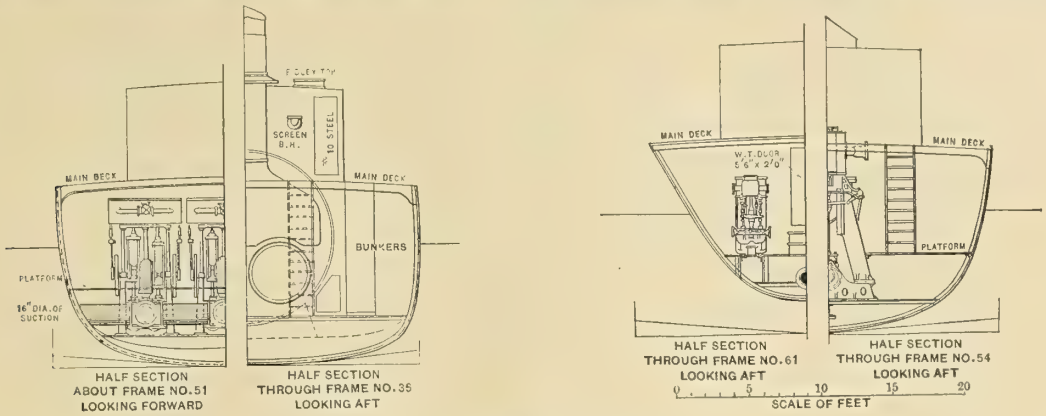
Name.	Length.	Displacement.	Indicated Horse Power.	Speed in Knots.	Speed in Miles.	Corresponding Speed in Miles for Length of 100 Feet.	Builder.
Areite	147.50	125	1,626	26.00	29.94	24.65	Thorycroft, England.
Nibbio	151.66	130	2,200	26.80	30.86	25.07	Schichau, Germany.
Cushing	137.50	105	1,650	22.00	25.33	21.60	Herreshoff, United States.
Falke	135.00	88	1,400	24.02	27.65	23.81	Yarrow, England.
Chevalier	144.00	118	2,700	27.22	31.34	27.08	Normand, France.
Hornet	180.00	220	4,000	28.00	32.24	24.03	Yarrow, England.
Adler	152.00	150	2,300	27.40	28.09	25.54	Schichau, Germany.
Boxer	205.50	250	4,487	29.17	33.59	23.42	Thorycroft, England.
Daring	185.00	229	4,700	29.26	33.70	24.78	Thorycroft, England.
Sokol	190.00	240	3,900	29.77	34.28	24.88	Yarrow, England.
Desperate	208.00	272	5,400	31.02	35.73	24.78	Thorycroft, England.
Forban	144.40	125	3,200	32.03	36.88	30.70	Normand, France.
Hart	194.00	245	4,143	27.00	31.00	22.32	Fairfield Co., Scotland.
Sunfish	200.00	290	4,500	28.05	32.30	22.84	Hawthorne, Leslie & Co., Eng.
Starfish	190.00	252	4,510	28.00	32.20	23.37	Naval Con. Co., England.
Bathurst	130.00	85	1,230	24.42	28.12	24 66	Yarrow, England.
Vamoose	112.50	66	800	19.55	22.50	21.22	Herreshoff, United States.
Porter	175.00	180	3,500	28.74	33.09	25.01	Herreshoff, United States.
Turbinia	100.00	44	2,100	32.75	37.71	37.71	C. A. Parsons, England.
Feiseen	85.00	16	590	27.43	31.60	34.27	C. D. Mosher, United States.
Norwood	63.00	9	400	26.50	30.50	38.43	C. D. Mosher, United States.
Ellide	80.00	13	910	34.73	40.00	44.72	C. D. Mosher, United States.

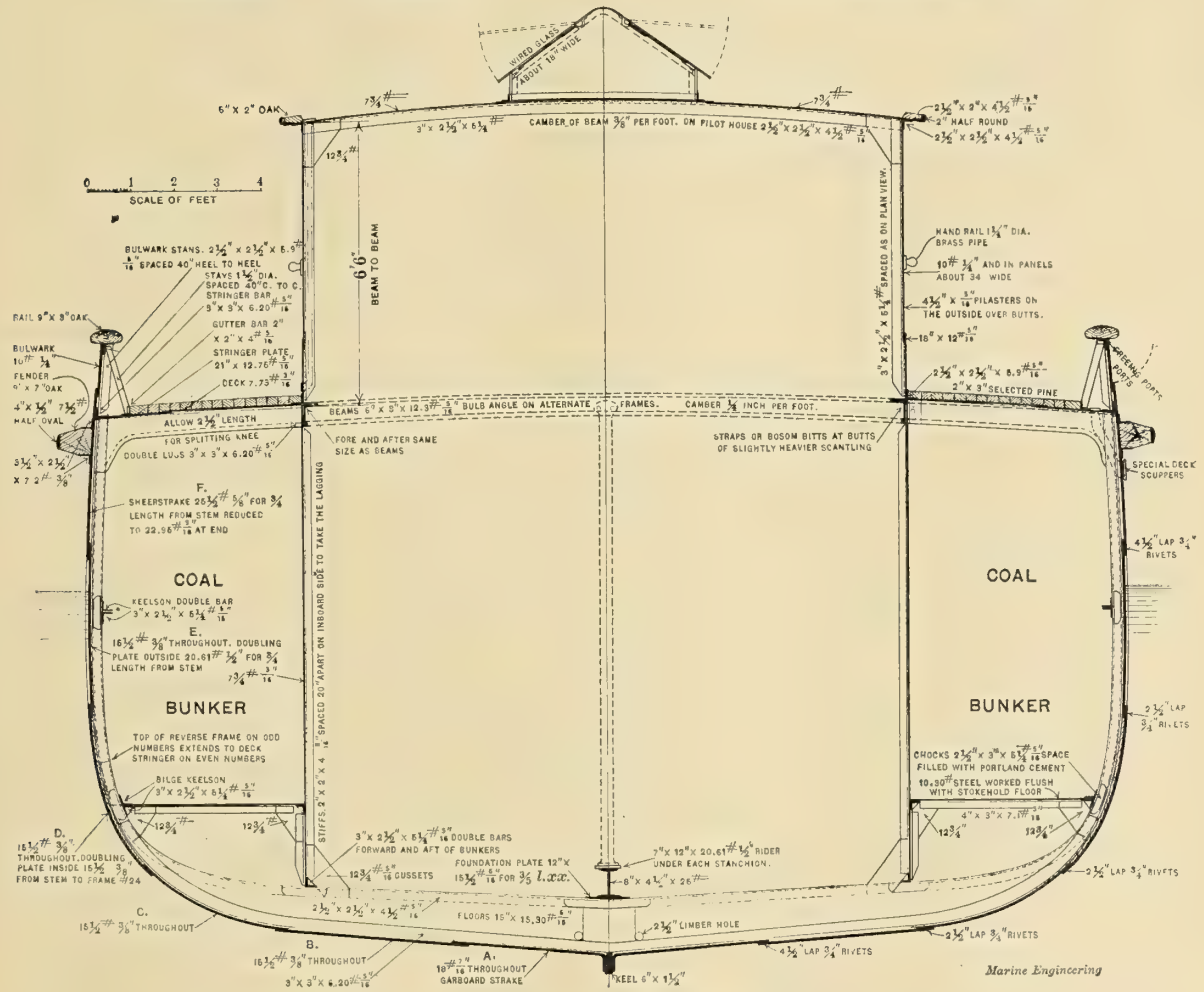
NEW AND POWERFUL FIRE BOAT FOR THE CITY OF CHICAGO.

A new fire boat for the city of Chicago, Ill., now under construction by the South Chicago Shipbuilding Co., will be one of the most powerful vessels of her type afloat. In the various drawings of the boat which we here publish the chief features of design and construction can be plainly noted. The Chicago Fire Department, one of the most efficient in this country and consequently in the world, has had much experience in the use of this class of vessel. The new vessel, therefore, embodies not only the most modern ideas in its character as a ship, but also is strictly up-to-date with respect to its fire fighting capacity. Plans for the vessel were drawn for the department in the office of A. W. Goodrich, of Chicago, and the contract was let last summer to the Chicago Shipbuilding Co., for $68,500, the price being for the boat, ready for service, excepting brass work, such as scuttles, timber heads, fairleads, etc., and all hose and appurtenances for fighting fire, which are supplied by the Fire Department.

The duty to be performed by a fire boat in the port of Chicago called for many special features of design and construction, for no mere floating pumping station would suffice for the exacting work there. The Chicago river, in both its north and south branches, along which lie extensive manufacturing plants, lumber yards and other dangerous risks, is a tortuous narrow stream. The traffic is heavy and consequently a boat which was intended to move quickly up or down stream should be extremely handy, susceptible to the influence of her rudder, and sufficiently strong not to be easily damaged by contact with vessels or wharves. Then during the long and severe winters much heavy ice is encountered, not only in the river but in the harbor, and as wharf fires in South Chicago are not uncommon, the heavy ice floes of Lake Michigan would have

to be bucked in running down the lake, between Chicago and Calumet rivers. The new boat is



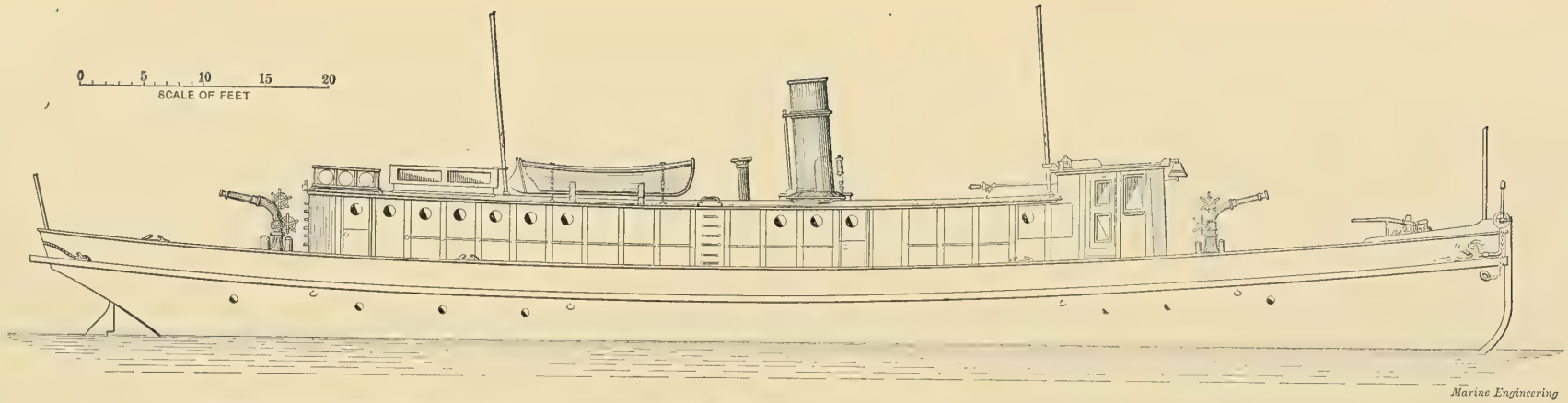

WIRED GLASS ABOUT 18" WIDE
5" x 2" OAK
CAMBER OF BEAM 3/8" PER FOOT. ON PILOT HOUSE
2" HALF ROUND
0 1 2 3 4
SCALE OF FEET
6'0" BEAM TO BEAM
BULWARK STANS.
RAIL 9" x 3" OAK
BULWARK
FENDER
GUTTER BAR 2" x 2" x 4"
STRINGER PLATE 21" x 12.76#
DECK 7.73#
HAND RAIL 1 3/4" DIA. BRASS PIPE
19" AND IN PANELS ABOUT 34" WIDE
4 1/2" x 5/16" PILASTERS ON THE OUTSIDE OVER BUTTS.
18" x 12"
2" x 3" SELECTED PINE
ALLOW 2 1/2" LENGTH FOR SPLITTING KNEE
DOUBLE LUGS 3" x 3" x 6.20#
BEAMS 6" x 8" x 12.37# BULB ANGLE ON ALTERNATE FRAMES. CAMBER 1/4 INCH PER FOOT.
FORE AND AFTER SAME SIZE AS BEAMS
STRAPS OR BOSOM BITTS AT BUTTS OF SLIGHTLY HEAVIER SCANTLING
SPECIAL DECK SCUPPERS
F.
SHEERSTRAKE 28 3/8# 5/8" FOR 3/4 LENGTH FROM STEM REDUCED TO 22.96# AT END
COAL
KEELSON DOUBLE BAR 3" x 21/2" x 8 1/8#
E.
16 1/2# 3/8" THROUGHOUT. DOUBLING PLATE OUTSIDE 20.61# 1/2" FOR 3/4 LENGTH FROM STEM
BUNKER
TOP OF REVERSE FRAME ON ODD NUMBERS EXTENDS TO DECK STRINGER ON EVEN NUMBERS
BILGE KEELSON 9" x 2 1/2" x 8 1/4#
STIFFS. 2" x 2" x 4" SPACED 20" APART ON INBOARD SIDE TO TAKE THE LAGGING
D.
16 1/2# 3/8" THROUGHOUT. DOUBLING PLATE INSIDE 15 1/2 3/8 FROM STEM TO FRAME #24
C.
15 1/2# 3/8" THROUGHOUT
B.
15 1/2# 3/8" THROUGHOUT
3" x 3" x 6.20#
3" x 2 1/2" x 8 1/4# DOUBLE BARS FORWARD AND AFT OF BUNKERS
FOUNDATION PLATE 12" x 15 1/2# FOR 3/5 L. ex.
GUSSETS
FLOORS 15" x 15.30#
A.
18# THROUGHOUT GARBOARD STRAKE
KEEL 6" x 1 1/2"
7" x 12" x 20.61# 1/2" RIDER UNDER EACH STANCHION.
8" x 4 1/2" x 26#
2 1/2" LIMBER HOLE
4 1/2" LAP 3/4" RIVETS
COAL
BUNKER
CHOCKS 2 3/4" x 3" x 8 3/4# SPACE FILLED WITH PORTLAND CEMENT
10.30# STEEL WORKED FLUSH WITH STOKEHOLD FLOOR
4" x 3" x 7.17#
2 1/2" LAP 3/4" RIVETS
Marine Engineering

CROSS SECTIONS OF THE FIRE BOAT ILLINOIS FOR CHICAGO, ILL.

built of Siemens-Martin steel and is of these dimensions:

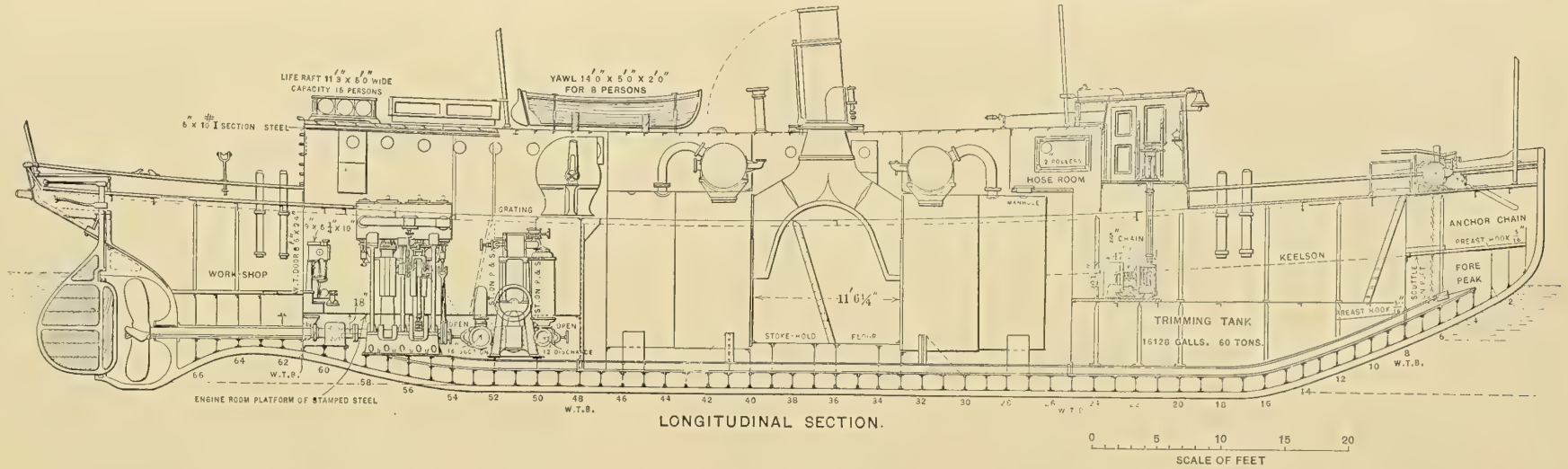
Length over all	118 ft.
" bet. perps	107 ft.
Beam molded	24 ft.
Depth hold	11 ft. 9 in.
" molded	12 ft. 6 in.
Draught	9 ft.

The hull is very thoroughly subdivided, having four athwartship water-tight bulkheads, a water-tight deck fore and aft forward, over the trimming tank, and in addition to these the coal-bunkers are carried along the sides in the boiler room. A bar keel, 6 in. by 1 1-2 in., is fitted and the skin plating is worked on in inside and outside strakes with vertical seams butt strapped. As shown in the profile the keel forward is carried in an easy sweep above the load water line, the forefoot being cut away considerably so that

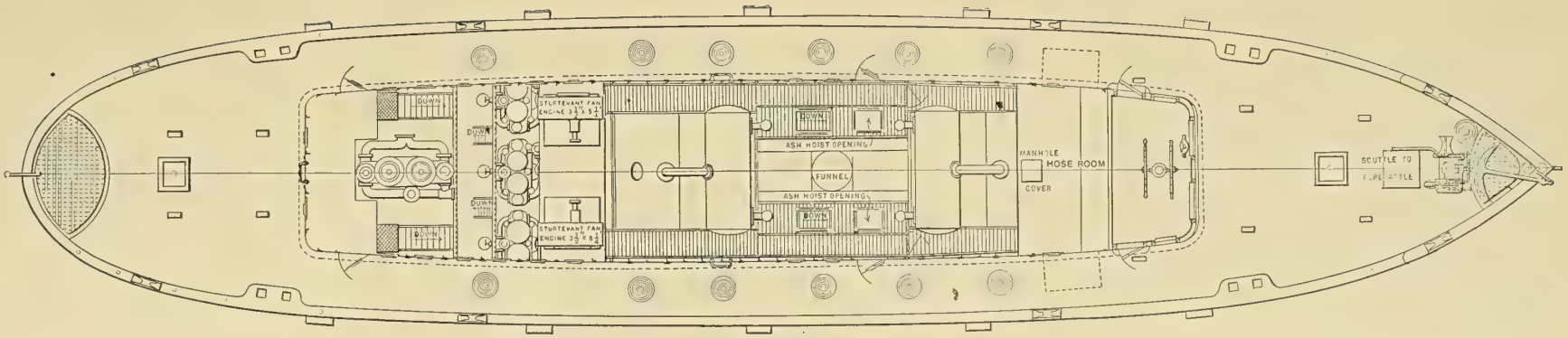


FIREBOAT ILLINOIS FOR CHICAGO, ILL., BUILT BY THE CHICAGO SHIPBUILDING CO., SOUTH CHICAGO, ILL.

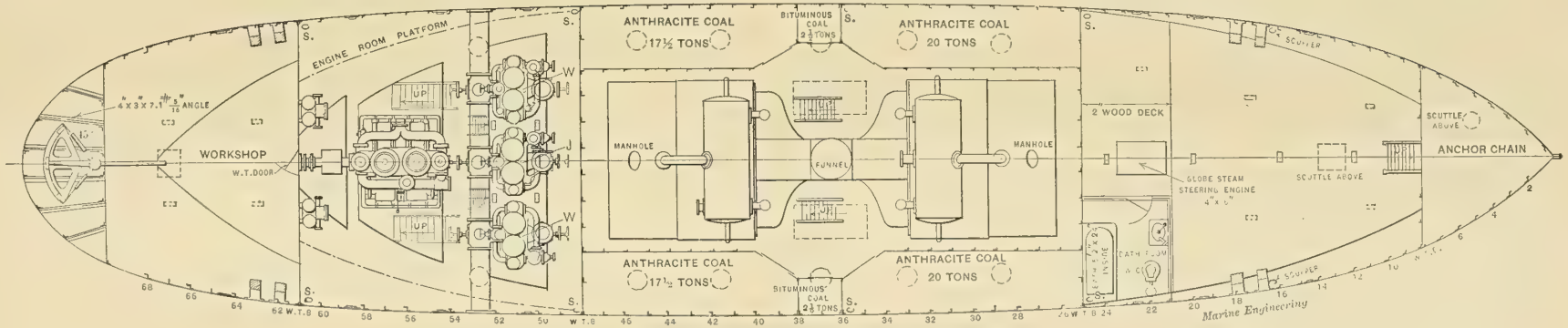
the boat can get on the ice easily and break it away. At the after end of the fireboat the keel is carried upwards in front of the propeller, giving a shallow draft here and enabling the boat to swing quickly in a short radius. The stem is of steel 6 in. by 1½ in. and the stern post and rudder post is cast steel in one piece 5 1-2 in. molded by 3 1-2 in. sided. The rudder is of large dimensions with iron frame forged in one piece, with stock 6 in. dia. at head and 4 in. at heel and pintle. It is filled in with white pine and rosin and plated with 10 lb. steel. The pintles are steel with metal sleeves turning in lignum vitæ bushings in the pintle hole in the rudder post, and the weight of the rudder is carried inside the hull by a collar on the rudder head, moving in a brass disk secured to a cast iron water-tight support. Dimensions of the hull material will be found on page 13.



LONGITUDINAL SECTION.



MAIN DECK PLAN.



HOLD PLAN AND MAIN DECK OUTLINE.

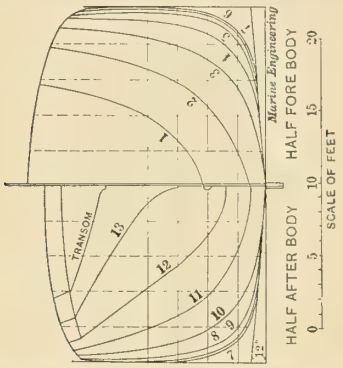
GENERAL ARRANGEMENT OF THE SINGLE-SCREW FIRE BOAT ILLINOIS FOR FIRE DEPARTMENT OF CHICAGO, ILL.

On the main deck a continuous deck house of 10 lb. steel occupies 69 ft. of the length by 14 ft. in width and rises to a height of 6 1-2 ft. at the side. In the forward end is the pilot house, finished in mahogany, with hardwood floor and the usual navigating apparatus. The steering wheel is connected by gears and a vertical shaft with a Globe Iron Works steam steerer below on the lower deck. The sides and roof of the pilot house are carried above the deck house level to give sufficient head room. Aft of the pilot house there is a hose room extending partly over the forward boiler in the boiler room. The engine and boiler trunks take up all the remainder of the deck house. On top of the house there is a yawl and patent raft, and a skylight with protected glass over the engine room. Below, the chain locker is located in the extreme forward end over the fore peak. It is constructed of 3-in. plank. Communication with the forecastle is had from the main deck by an oak ladder. This compartment is fitted with hooks and can be used for firemen's clothes. Just forward of the machinery spaces on the lower deck is the steam steerer, before referred to, and to the starboard side a water closet and lavatory. This is piped with hot and cold water in bath tub and wash bowl, and all the fittings are of the very latest sanitary model. The room is finished in white gloss paint with tiled floor. Next, the boiler

and engine rooms take up the greater portion of the boat's length. Aft of the engine room there is a workshop between decks with benches and vise. There are two air ports and four deck lights in this room, and a small square brass scuttle with rollers fitted in the main deck for taking hose through. Communication with the workshop is had through a water-tight door in the engine room.

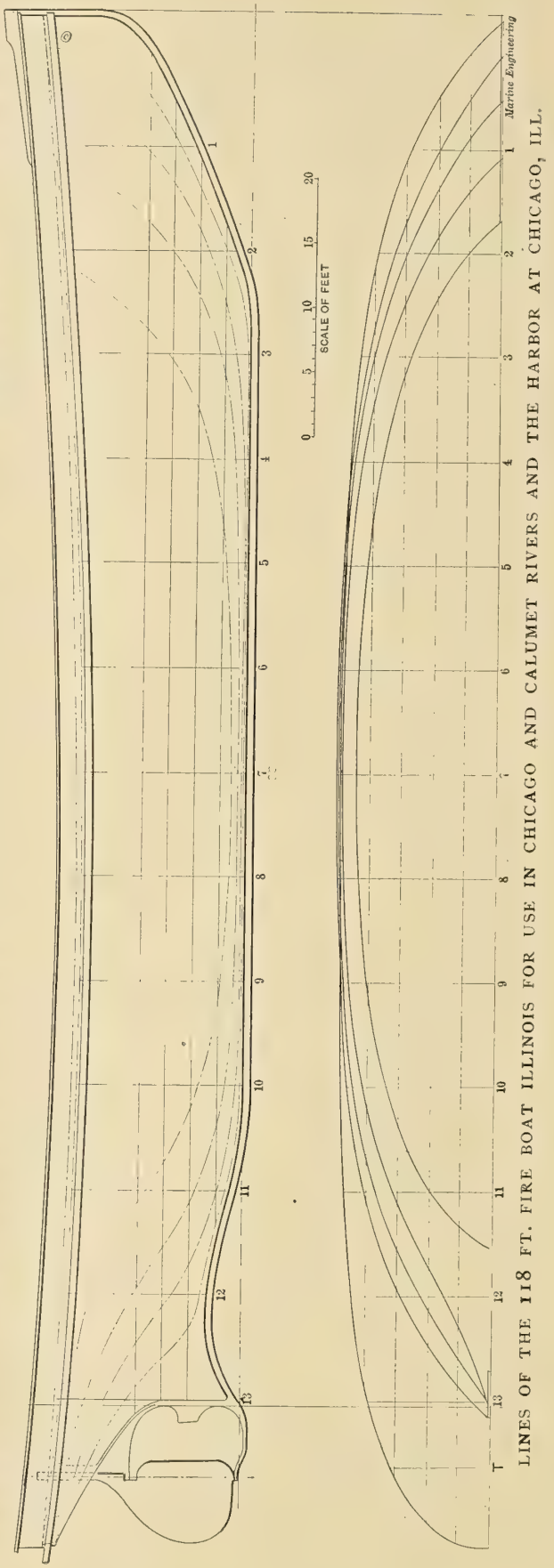
In the way of deck appliances the boat has a steam windlass on the forecastle, built to work a 1-in. chain on the starboard side and a heavy mooring warp on the port side. An anchor davit with all necessary tackle is so arranged that when not in use it can be lashed on deck under the anchor grating. An anchor weighing about 700 lbs. and 25 fathoms of 1-in. close link chain will be supplied. There is a complete equipment of bitts, chocks, cleats, fair leaders, and timber heads. Ample runways and special deck scuppers are provided to rapidly carry overboard all surplus water. A low steel bulwark of 10-lb. plate is carried all around, with top rail of 9-in. by 3-in. seasoned oak.

A minimum amount of wood work is used in



the construction for obvious reasons. The main deck is planked with 2-in. Michigan pine and the lower deck is similarly laid and calked. Over the forecastle companion-way there is a flat top hatch, 29 in. by 32 in. finished in mahogany and brass hardware. This is surrounded on three sides by a white metal guard rail 30 in. high, entrance to the hatch being on the fore side only. A jackstaff at the bow and flagstaff at the stern are fitted and two tall flagstaffs on the top of the deck house as indicated in the profile, page 10.

The propelling engine is of the vertical inverted two-crank, high-pressure type, driving a single screw. The two cylinders are 20 in. dia. and 20 in. stroke, to work with boiler pressure of 140 lbs. They are carried on rear columns of cast iron and front columns of wrought iron turned. The bed plate is cast iron of box girder section with three main journals 10 in. long. The connecting rods are wrought iron 4 ft. 6 in. between centers, 4 in. dia. at the upper neck, and 4 1-2 in. at the lower, with upper ends forged solid and eyes slotted out. Cast steel is used for the crossheads, which are fitted with brass slippers and pins 5 in. dia. and 3 in. long. The



LINES OF THE 118 FT. FIRE BOAT ILLINOIS FOR USE IN CHICAGO AND CALUMET RIVERS AND THE HARBOR AT CHICAGO, ILL.

pistons are "semi-steel" and the rods forged steel 4 1-2 in. dia. They are tapered in the pistons and secured with a nut, and also tapered in the cross-heads and there keyed. Stephenson double-bar link motion is used, with cast iron eccentrics, wrought iron rods, steel valve stems and hard brass link blocks. These are fitted with adjustable gibs. Hammered iron is used for the crank shaft, which is 8 in. dia., with couplings forged on, and also for the pins, the crank slabs being of cast steel. The thrust and line shafts are both of iron 8 in. dia.

Cast steel is the material used for the propeller. It is four bladed, 8 ft. dia. and 10 ft. true pitch, made extra heavy and modeled so as to give fair efficiency when backing.

Auxiliaries include two Worthington Admiralty type duplex pumps placed against the after bulkhead of the engine room. These have cylinders 9 in. by 5 1-4 in. by 10 in., and are for boiler feed chiefly. A Worthington duplex sanitary pump with cylinders 4 1-2 in. by 2 3-4 in. by 4 in. is also included, with both sea and fresh water connections. Communication between the pilot house and engine room is by Cory mechanical telegraph.

Forward of the propelling engine in the same compartment is a set of fire pumps, consisting of three double acting, vertical, single, duplex, crank and flywheel pumps. The steam cylinders are 17 in. dia. and 11 in. stroke, of cast iron with piston valves. The pump ends are composition, with water cylinders 10 in. dia. and 11 in. stroke. Each pump is to have a minimum capacity of 3,000 gallons a minute, with a pump pressure of 170 lbs. per sq. in., the steam on the boilers not being less than 125 lbs. The pumps are designed with large free passages and valves and large suction and air chambers. The running parts are steel and the pump rods Tobin bronze. The weight of the three pumps and necessary appliances is limited to 40,000 lbs. They were built by the American Fire Engine Co., of Seneca Falls, N. Y.

Connecting with the set of pumps there are two 10-in. circuit pipes running along the sides just below the main deck and coming together just forward and abaft the deck house in two stand pipes shown in the outboard profile. These stand pipes are fitted with adjustable nozzles and when in operation will be capable of sending solid streams of water a tremendous distance from the boat with force sufficient to demolish any ordinary brick wall. At intervals along the sides of the deck house there are valves and hose connections with these pipes protected by steel boxes.

There are two single-ended return-tube boilers 12 ft. dia. and 11 ft. long, fitted front to front with an athwartships fire room between. Each has a steam drum crosswise of the boiler, 42 in. dia. and 9 ft. long. Each boiler has two Morison furnaces 48 in. dia. by 8 ft. 5-8 in. long and has separate combustion chambers, 29 in. wide at bottom and 26 in. wide at top, with a 6 1-2 in. water space between chambers. There are 228 tubes, 2 3-4 O D, 8 ft. 2 in. long and 11 B. W. G. thick. The boilers are built of 60,000 lb. marine steel to withstand a working pressure of 140 lbs. Each boiler has a breeching of No. 8 steel connecting with the funnel which is common to both. The funnel is 36 in. dia., of No. 10 steel, and is hinged so that when passing under river bridges it can be promptly lowered. There is an arrangement for forced draft, two direct driven Sturtevant steel plate fans being fitted over the fire pumps in the engine room, as shown in the section on page 10. These are driven by engines 3 1-2 in. by 5 1-4 in. and have a capacity of 16,850 cu. ft. per minute. The boilers are fitted with the necessary air tight doors and dampers for use when working with forced draft.

For lighting the vessel there is one electric direct connected set supplying current for 100 16 C.P. lamps. Ash hoists are fitted on each side of the stroke hold.

Severe tests of all material were imposed and in general construction the new boat conforms to Lloyd's rules for first-class steel vessels. She was built under the supervision of Naval Architect W. J. Wood, of Chicago, acting as representative of the Fire Department, and was recently christened the Illinois. We take pleasure in acknowledging the courtesy of the Chicago Fire Department in furnishing us with data and drawings, used in the preparation of this description.

Data for Hull Construction of Fire Boat Illinois for Chicago Fire Department.

SCANTLING.

Frames 3 in. × 3 in. × 6.20 lb. — $\frac{5}{16}$ in. spaced 20 in. apart heel to heel.
Frames spaced 16 ft. apart for about 20 ft. abaft stem.
Double frames on all Watertight Bulkheads.
Reverse frames 2½ in. × 2½ in. × 4½ lb. — $\frac{5}{16}$ in. extending to Deck stringer plate and to 12 in. above upper bilge stringer alternately.
Floor plates 15 in. × 12¾ lb. — $\frac{5}{16}$ in. and 15 in. × 15.30 lb. — $\frac{5}{16}$ in. in Eng. and B. space.
Keel and Stem 6 in. × 1½ in. Scarphs 18 in.
Stern frame 5½ in. × 3½ in. Scarph 32 in.
Rudder head 6 in. dia., heel and pintle 4 in. dia.
Rudder plating 10 lb. per foot, ¼ in. bare.
Bulkhead plating 10.30 lb. — ¼ in. Stiffs. 3 in. × 3 in. × 5 lb. — ¼ in.
Coal Bunker Bulkhead plating 7¾ lb. — $\frac{3}{16}$ in. width.
Stiffeners of angle bar 2 in. × 2 in. × 4 lb. — $\frac{5}{16}$ in. spaced 20 in. apart.
Solid Hold Stanchions 3 in. dia. wherever possible.
Screen Bulkheads on Circumference of Boilers, No. 10 B.W.G. — 5.45 lb.
Angle steel stiffeners 2 in. × 1⅜ in. × 2.1 lb. — $\frac{3}{16}$ in. laid diagonally.

BUTTSTRAPS AND RIVETING.

Shell plating single riveting longitudinally 2½ in. laps, ¾ in. rivets. Buttstraps 9¾ in. wide and $\frac{1}{16}$ in. thicker than the plates they connect and double riveted throughout.
Sheerstrake and Garboard strakes double riveted, laps 4½ in. wide, ¾ in. rivets. Buttstraps of Sheerstrake to be worked up to Bulwarks, thro' stringer plate.
Buttstraps of Deck stringer 11¾ in. wide and treble riveted with ⅝ in. rivets, Straps on under side of stringer plate, and flush riveted on top.
Deck plating butts lapped 3¾ in. wide and treble riveted with ⅝ in. rivets, flush on top.
Deck seams single riveted 2½ in. lap ⅝ in. rivets flush above.
Bulkhead plating single riveted 2¼ in. lap ⅝ in. rivets finished with snap tool button points.
Floors double straps, 14¼ in. × 10.3 lb.— ¼ in. treble riveted ¾ in. rivets.
Where thicknesses and weights of material differ, take weights.

SUBMARINE TORPEDO BOATS: THEIR INFLUENCE ON TORPEDO BOAT ARCHITECTURE AND VALUE IN WARFARE.*

BY CAPTAIN WILLIAM H. JAQUES.

Although actual warfare may be the only definite means of establishing the value of new developments in naval architecture, it is too expensive a means to depend upon, and the awaiting of its solution would subject us to the enormous disadvantage of want of preparation and proper insurance which demand an earlier decision upon the questions involved.

Fortunately, the peace and prosperity of the great nations have not been disturbed frequently enough by war to secure their dictum that the generally accepted type of torpedo boats is one which has not come to stay; but there is evidence enough in the results that obtained in the late Japan-China war; in the discomfort of life on board; in the accidents incident to manœuvering; their unfitness for serious work at sea; the great fatigue to which the crews are subjected; and the marked strides in torpedo boat construction to reach speed, protection and a reasonable defensive power to convince us that the present torpedo craft, whether she be carried on a battleship or is a torpedo boat destroyer, is neither sufficiently protected nor invisible, nor can she keep the seas without ruining her personnel.

The torpedo boat experience gained in the Japan-China war especially demonstrated the fact that the ordinary torpedo boat had more defects than enduring or reliable qualities, and there is abundant evidence, certainly, to suggest, if not convince, that there must be some radical change in the present torpedo boat architecture.

The desire or attempt to produce a submarine boat for war purposes is not by any means new, nor have the controlling elements of design been restricted to one principle, except in the Holland system, with which John P. Holland has for so many years been directly associated.

It must not be forgotten that some of the leading and most generally accepted principles of the present battleship were taken from the American monitor, a type that for many years was practically discarded, but which during the United States Civil War in the crisis of 1861 accidentally but completely—and practically against the ideas of the naval officials—gained such a decisive and remarkable victory as not only to largely influence the course and conclusion of the Civil War, but to impose conditions on subsequent naval architecture that have been universally accepted. And this victory was gained directly in the face of the most intense opposition of naval officials. If the late monitor had not had the opportunity of war to prove her value, it is extremely doubtful if she would ever have had such an important place in naval history or naval architecture.

* A paper read at the Thirty-ninth Session of the Institution of Naval Architects, London.

All treatises on torpedo-boats, all reports in connection with their construction and supply, all references to their achievements, emphasize, more or less, the requisite of invisibility and power to reach an enemy, and to successfully get torpedoes into an enemy's ship.

The development of the submarine boat, its power to disappear, its ability to move quickly, its valuable element of submergence, the practicability of protecting by armor, its limited visible portion, and the surety of its fish-like qualities, must have a radical influence in modifying the present types of torpedo craft, no matter whether it replaces the second-class torpedo-boat on board a battleship, whether it is employed for submarine purposes pure and simple, or, as most probably will be the case, its submarine principles are utilized to protect the semi-submerged torpedo-boat and to meet the practical conditions sought for in combining such invisible and protective qualities as will enable the torpedo-boat to surely get in her work.

EARLY SUBMARINE BOATS.

The literature of the early history of submarine navigation is, more or less, familiar to all, and while nearly all of the experimental boats, even those of the seventeenth century, have thrown some light on the subject, the "Plongeur," the Nordenfeldt boats, those of the Goubet type, those of the Alexandrofsky principle and the "Holland" have received the most prominence and attention. In these all sorts of mechanical contrivances and powers—compressed air, electricity, petroleum and reservoired heat—have been separately or collectively employed. It is by a careful study of what has been done in these types, and of what has caused their failures, added to the benefits and advantages which industrial development has provided in mechanics, metallurgy and electricity, that we are able to present to-day a craft built on the vital Holland principles, which we believe will be not only of great value to naval architecture, but of great usefulness in war, and which will have a powerful influence in the removal or reduction of the defects of the present torpedo-boat.

FOUR ORIGINAL HOLLAND BOATS.

Before describing the two submarine boats, the "Plunger" and the "Holland," now receiving so much attention in the United States, let me say a few words about the four boats built under Mr. Holland's direction, and in and with which he made the experiments that made his final success possible.

Boat No. 1 was built in 1877 by the Albany City Iron Works, of New York. Her dimensions were 14 ft. 6 in. long; 3 ft. beam, and 2 1-2 ft. deep; she had a double body, the inner one being cylindrical; water space between them. She was operated by a 4 H. P. petroleum engine with one screw, and had vertical and horizontal rudders.

Mr. Holland experimented with this boat for nine months, and, although her petroleum engines were a failure, and the speed was very unsatisfactory, he proved that he could submerge her at will and keep her under water, and determined that the horizontal rudders were useless when placed in the transverse axis, but effective when at the stern.

After he demonstrated that it was possible to control the boat under water, he had the engines pulled out, and sank it under the Fall's Bridge at Paterson, N. J., where the hull now lies in the Passaic river.

Boat No. 2 was commenced in 1879 at the Delamater Iron Works, New York city. She was finished and delivered to Mr. Holland in April, 1881; he started experimenting with her immediately, and continuing until October of that year. In that boat he made most of his experiments. She was 31 ft. long; 6 ft. in diameter; 19 tons displacement, and was fitted with a 15 H. P. Brayton petroleum engine. With a crew of one engineer and himself he cruised all over the harbor of the North river. Most of his experiments were made under water. As an example of the perfect control of pressure, Mr. Holland relates that, with the boat submerged and resting on a gravel bottom, the engineer opened a bottom manhole, stepped out (without a diving suit), lifted the hull slightly with his hands, and then got in again and closed the manhole.

With her armament of a submarine gun 10 ft. 2 in. long and 9 in. bore, he succeeded in getting a perfectly straight projectile trajectory under water for about 40 yards. To fire the submarine projectile he used 200 pounds air pressure; the highest was 495 pounds, but it did not appear to make much difference in the range; 250 pounds did nearly as well. The Delamaters built the projectile. This particular pneumatic gun was made of a welded steel tube, and was the foundation for the pneumatic gun system that was afterwards developed under the management of the Pnuematic Dynamite Gun Company. This craft is now lying at New Haven, Connecticut. Her engine is still in her, but the air compressor was taken out about two years ago to run a forge.

Boat No. 3 was built at Ganning's Copper Shop, Jersey City, New Jersey, and was a working model. In her Mr. Holland first employed the apparatus for steering under water in the horizontal plane; he intended to build a gunpowder engine to propel her under water, but, before he accomplished this, she was sunk opposite Whitestone, the engineers, not understanding how to fasten the turret, having left it open about half an inch. A few experiments under water were made before the accident. She was 16 ft. 4 in. in length by 28 in. diameter, and of one ton displacement.

Boat No. 4 was known as the Zalinski boat, and was built at Fort Lafayette, of composite iron frame, planked with wood; she was 40 ft. long, 8 ft. diameter, and it was the intention to arm her with large Zalinski pneumatic guns. The launch was mismanaged, the ways broke under her, she fell on the rocks and was seriously damaged. She was repaired sufficiently to carry on experiments at the dock, where she was frequently submerged, and much information secured concerning the control of water ballast. She was finally broken up.

In all these boats Mr. Holland's fundamental principle was to dive, and not to "control" them, as in the foreign types, either by the inlet, or outlet, of water, or by down-haul screws alone.

RESULTS OF EXPERIMENTS.

The main things proved by these experiments were: That in submarine boats it was essential to have an unmovable center of gravity; that the movable center was the cause of nearly all the failures; that during the submarine run the weight must remain absolutely unchanged, being kept the same automatically, otherwise she cannot dive when you desire it, or she may run to too great a depth. Another thing demonstrated was the value of a boat that would be as small as possible, consistent with having sufficient offensive power. It must also be quick-acting, so as to be able to come to the surface and to disappear as rapidly as a porpoise. A cardinal principle governing its design is simplicity.

SUBMARINE BOAT "PLUNGER."

While there have always been naval officers in the United States who have advocated the value of submarine boats, and the Navy Department has at various periods interested itself in them, the advertisements of November 26, 1887, and May 1, 1893, called forth the most important proposals, and a contract was entered into with the Holland Company in 1895.

The one constructed by the Holland Company for the United States Navy Department was named the "Plunger" by the department, and was launched August 7 last, at the constructor's yard in Baltimore. She is the fifth one designed by Mr. Holland, and is 84 ft. long, of circular section, 11 ft. 6 in. in diameter, surface displacement 149 tons, submerged displacement 165 tons, with a reserve buoyancy of about a quarter of a ton. The guaranteed speed is 15 knots on the surface and 14 knots while awash, with 1 ft. of the turret above the water. Her totally submerged electrically running speed must be 8 knots for six hours. There is a turret amidship with 4 in. of protection and a superstructure for fair weather. Two down-haul screws have been added, although they are not considered by Mr. Holland a requisite of the system. There are two openings in the nose-piece through which service torpedoes are to be discharged. In addition to hand-gear for horizontal steering and diving, there are automatic devices for maintaining submergence at predetermined depths. A camera lucida has also been fitted. The hull has been constructed to admit a submergence of

75 feet. Some of the water-tight compartments serve as water tanks; others contain oil fuel; others are employed for compensating discharged weights. A special device compensates for the oil consumed. There are four rudders, two for steering horizontally and two vertically, controlled by automatic devices.

For running on the surface or awash, steam generated by pertoleum is employed, while electricity from storage batteries is used under water. There is one water-tube boiler of the Mosher type of 3,000 sq. ft. heating surface, fitted with a system of oil fuel capable of consuming 2,000 pounds of oil per hour. There are two main, vertical, triple-expansion steam engines of 600 H. P. each, and one auxiliary of the same type of 300 H. P.

The electric machinery is composed of one main motor of 70 H. P. for propelling the boat when submerged, operating either the side or center shaft, or used as a dynamo for recharging batteries. There are additional electric motors for operating down-haul screws and performing other services as required.

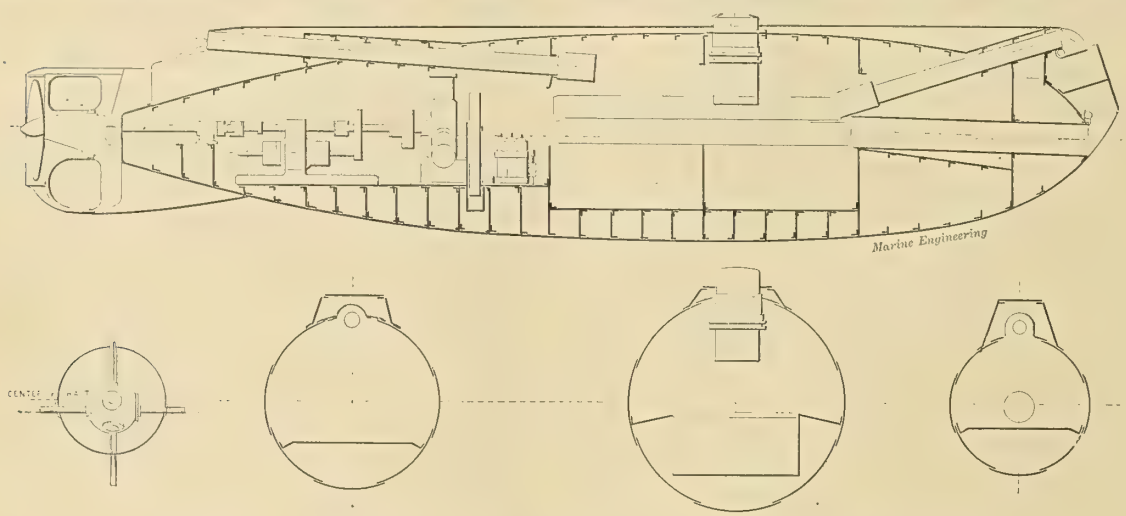
Air for tank and ventilation service is supplied from commercial reservoirs. There are special fittings for closing smoke pipe and air ducts quickly before submerging, and the tank operations are very simply controlled by Kingston and compressed air reducing valves. The "Plunger" has three propellers (in addition to the down-haul screws), any one, or all of which can be operated by either steam or electrical machinery.

DESCRIPTION OF THE "HOLLAND."

Owing to the delays incident to the many modifications of the "Plunger," constructed for the Navy Department at the Baltimore shipyard, the Holland Torpedo Boat Company decided to build a boat into which the essential elements of Mr. Holland's type could be introduced and experimented with by the company, and boat No. 6, the "Holland," was built at the Crescent Shipyard, Elizabethport, New Jersey, by Lewis Nixon. Its form resembles that of the porpoise and its dimensions are:

Length	50	ft.
Diameter	11	"
Displacement, light	119	tons.
" with superstructure awash	138	"
" submerged	139	"
Reserve buoyancy	0.7	"

In this boat no attempt was made to secure a higher speed than was necessary to secure proper diving and steering properties. It was fitted with a 50 horse power gasoline engine for surface runs, air compression and storage battery charging, and a 50 horse power electric motor for submerged work. Its armament consists of one 18 in. service torpedo tube and two dynamite guns fitted for powder and compressed air discharge. At a speed of 8 knots the "Holland" maneuvers, steers and dives beautifully, and the control of submergence is speedily and easily effected by the operation of Kingston and compressed air reducing valve. Her stability has been thoroughly proved and the atmospheric conditions when submerged are infinitely safer and more comfortable than those of the ordinary torpedo boat. From four to six men are required for her operation.



SECTIONAL DRAWINGS OF THE HOLLAND SUBMARINE TORPEDO BOAT.

ARMAMENT OF SUBMARINE BOATS.

Although the Holland Company has several designs, simple and novel, for the armament of submarine boats, in the presentation of this paper it is not intended to ask your consideration of them; for the boats themselves can be readily fitted with Whitehead or Howell torpodoes, employing powder or compressed air discharge, or with over-water projectiles fired with either powder or air or a combination of both.

FACILITIES FOR BUILDING BOATS.

If these vessels are to be supplied in large numbers; if they are to be quickly built and to become speedily available for the crises which ar-

rive to every nation, their advantages can be more readily understood when it is known that the elements of which they are composed and built are commercial products. Gas and steam engines can be secured from a hundred builders; electric motors have replaced and are as easily procurable as horses; electric storage batteries, although still far from being fully satisfactory are no longer novel and difficult to obtain; compressed air cylinders are increasing every day in strength and capacity; petroleum fuel can be carried with less danger than bituminous coal; and the parts which compose the special controlling mechanisms of the system are all marketable products, easily and quickly assembled and adjusted.

RESULTS SOUGHT IN DESIGN.

In the design and construction and practice with the Holland submarine boats "Plunger" and "Holland," we have been going on the principle of developing not a boat simply as a toy or a working model, but one which will be especially useful for the primary purpose to which a submarine boat should be put—that is, of actually fighting vessels around the harbors and on the coast, instead of in the open sea.

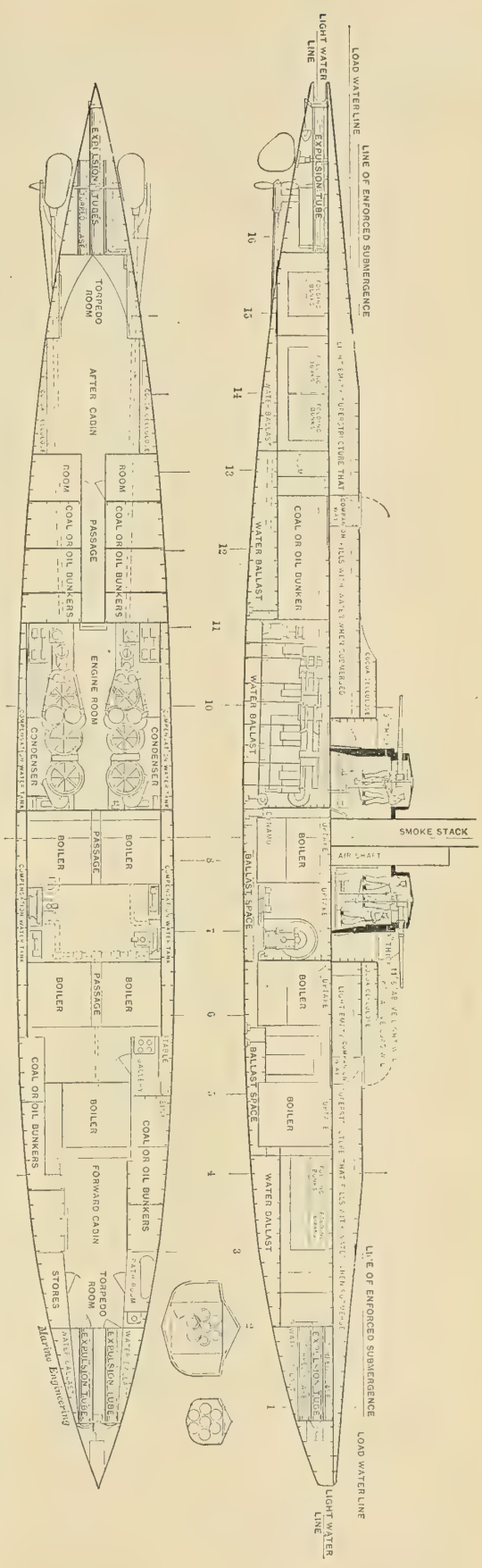
The dimensions of a submarine boat proper should be governed by the necessary offensive power, and while having in it all the destructive power desired, it should be small enough to get close up to and, practically, nibble at the bottom of the ship to be destroyed. This object appears to have been accomplished in the "Holland," for she has all the speed necessary to control her fish-like qualities, has power to disappear, can take care of herself, and, at the same time, is able to work three very powerful guns.

While this has been accomplished no doubt other valuable developments will be in the direction of small craft to take the place of second-class torpedo boats and battleships, and of semi-submerged boats of almost any dimensions, having armor enough above water to afford ample protection, at the same time protecting all the rest by water.

ARMORED SEMI-SUBMERGED BOAT.

We all know how difficult it is to adequately protect a ship with armor even by a most careful distribution of weights. The semi-submerged boat presents a type in which you can armor such parts as are necessary, employing very heavy armor, because you have reduced to a minimum the part exposed, and possessing submarine qualities it is the only kind of boat that will do this, as it is well known there is not a torpedo boat in existence to-day that will meet these conditions.

In such a craft one can get close up to a ship and fire the torpedo into her, while an ordinary torpedo boat will be simply riddled and sawed into pieces by rapid-fire ammunition. Further, a semi-submerged armored torpedo boat will be able to get so near her target that by greatly re-



GENERAL ARRANGEMENT PLANS OF PROPOSED SEMI-SUBMERGED ARMORED TORPEDO BOAT DESCRIBED IN CAPT. JAQUES' PAPER.

ducing the range she will eliminate many of the disadvantages of the present long ranges required for the Whitehead torpedo. Again, a well disciplined crew is given a chance to do something, for their quarters will be infinitely more comfortable than those they at present occupy in the torpedo boat; they will have a feeling of safety which they do not now enjoy, and they will know that they will land their torpedo close enough to blow up the ship. Such a craft may be compared with a large automobile torpedo, one of such a size to carry a crew, and yet possessing not only similar automatic devices for controlling its position, but having them supplemented by direct mechanical contrivances under the direct control of the brain of man. Such a boat will be practically irresistible and invulnerable; will even resist the attack of heavy ordnance, and is a type that it will be impossible for a battleship to avoid.

While giving importance to the designs that will utilize the semi-submerged principles, the great need of the hour for harbor and coast defense is a small torpedo boat that can be submerged, having within it a storage battery of sufficient power to give it a submerged range of a few hours, with 9 or 10 knots surface speed, and from 6 to 8 knots submerged.

PROGRESS IN SUBMARINE BOAT CONSTRUCTION.

It will perhaps be said that very little has been accomplished in submarine navigation in proportion to the number of years during which the system has been under consideration and experiment, but it must be remembered that the best commercially accepted torpedo—the Whitehead—has struggled through many years, is yet very far from being perfect, and directive power for it has only recently been secured by the introduction of the principle which was the controlling one of the Howell—that is, the gyroscope. One must also recall that most torpedo destruction has been done with a bag of explosive on the end of a pole, and that the submarine boat will permit us to get closer to the enemy, with a bigger bag of explosive, and with less danger to the pole.

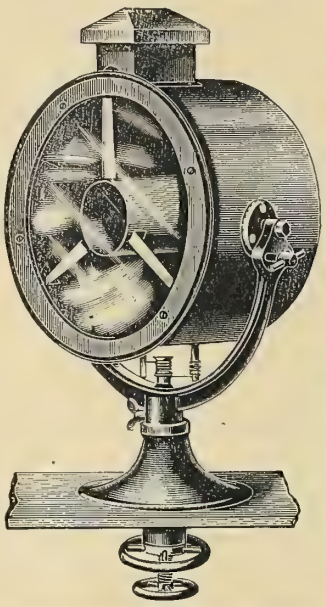
If one compares directly the chance of the ordinary torpedo boat with that of a submerged boat for landing a torpedo, there certainly can be but very little doubt as to which is the more hazardous.

If there are no other elements of value in the submarine boat than its influence upon a modification of the present type of torpedo boat, this alone should certainly give it prominence and weight—a powerful influence which certainly cannot be ignored.

The annual meeting of the American Society of Naval Engineers will be held in Washington, D. C., commencing Tuesday, January 10, 1899. Several prominent engineers have given assurance that they will prepare and read papers.

IMPROVED APPARATUS.

Acetylene Light.

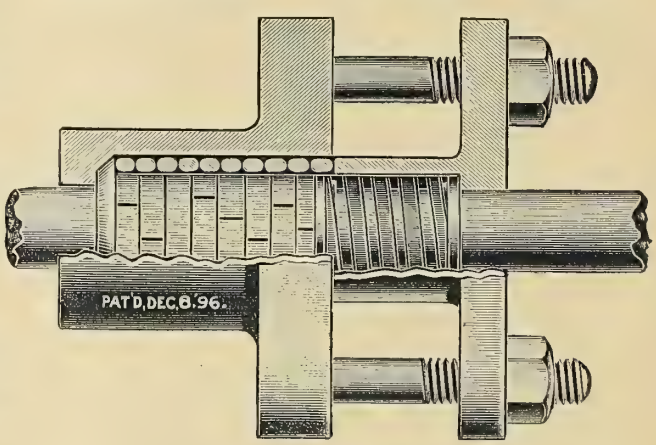


ACETYLENE SEARCH LIGHT.

Our illustration shows a new pilothouse light designed to burn acetylene gas. It is in fact a small search light with a power of 2,000 candles, which the manufacturers guarantee, with the use of a 1-2 ft. burner, 25 candle power. Any object within a radius of 600 yards upon which the beam is projected can be readily seen, and under the most favorable circumstances objects 1,000 ft. distant are rendered visible. The makers are J. B. Colt Co., 7 West 29th street, New York.

Rigby Metallic Packing.

The packing here illustrated consists of a series of split rings made of a suitable composition, which are closely fitted to the rod and held in position by a coiled spring bearing on the gland head. The stuffing box outside of these metal rings is packed in the usual way with special flexible packing, which is compressed by the gland ring. Thus it will be seen that as the gland nuts are screwed down, the flexible packing is expanded laterally and brings the metal rings to close snugly about the rod. The manufacturers,



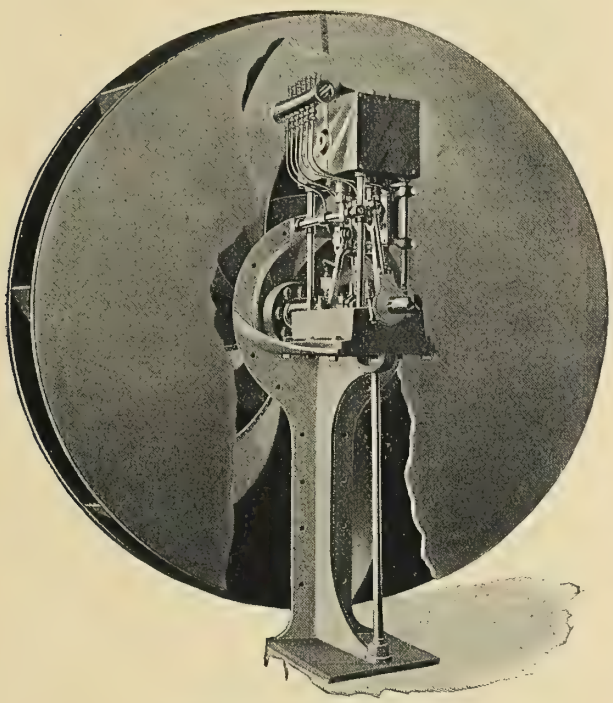
RIGBY METALLIC PACKING.

The Henry S. Mould Co., Carnegie Building, Pittsburg, Pa., claim for this packing minimum friction, simplicity of construction, ease of operation and great durability. Unlike many other

makes of metallic packing, it is not dependent upon the steam pressure for its compression, by which design the friction at the stuffing boxes increases proportionately with the load.

Engine Connected to Blower.

The engine shown in the illustration direct connected to a blower is a compound built by W. D. Forbes & Co., Hoboken, N. J. The cylinder dimensions are: High pressure, 2 1-2 in.; low pressure, 4 in., and stroke, 4 inch. It is designed to run at 800 revolutions. The cranks are set at 180 deg. apart. All forgings are of high grade machinery steel without welds. Provision is made for taking up all possible wear, and a very satisfactory system of oiling by means of a drip feed is fitted to the engine. The apparatus here illustrated has been in constant use

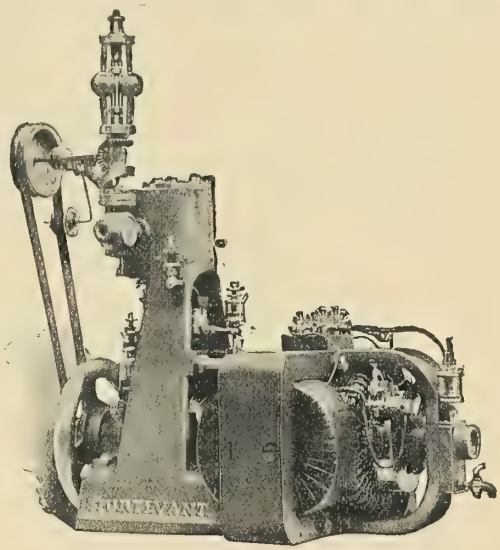


FORBES ENGINE AND BLOWER

for the past eight months with exceedingly satisfactory results. This type of engine is also adapted for marine propulsion, being fitted with reversing gear when required for small launches. The firm, in fact, makes a specialty of high grade compact engines.

Small Sturtevant Lighting Set.

The lighting outfit here shown was designed for torpedo boat service, and several of these sets have already been furnished to the United States Navy. The engine, which has a cylinder 2 in. by 2 in., is compact, extremely stiff and carefully designed as regards adjustment of wearing parts and the character and proportions of the material employed. Steam is admitted through a special form of throttling governor, which is capable of controlling the speed of the engine within very close limits. All moving parts are provided with continuous sight feed oilers. The engine was designed with a large factor of safety to operate under 200 lbs. pressure at 1,000 revolutions and indicate 3 H. P., although intended to be operated at a somewhat less output. The specified limit of weight of the entire set was 500 lbs., the rated capacity of the engine to be 1.5 K. W. In point of fact, the finished machine weighed only 400 lbs., thus coming 100 lbs. inside the specified limit, bringing the weight efficiency down to 0.266 lbs. per watt at rated capacity. The center of gravity of the set was kept as low as possible in order to economize head room and to insure steadiness in running. This low center demanded a special design, which was met by the adoption of a four-pole field, with only two field coils on the consequent-pole type of magnetic circuit. The field magnet itself is of wrought iron, the pole pieces of the same material being bolted to it. Thorough ventilation and a large radiating surface are secured by making the armature of large diameter. By means of air-ducts placed at the center and ends of the armature core, the armature is to a certain extent transformed into a centrifugal blower and thorough ventilation is secured. As the back end of the spider is completely closed and thereby rendered oil proof, the air is necessarily drawn through the commutator. Only two brush holders are used as the armature is of the two circuit, four-pole, barrel-wound type without cross connections. These brush holders are of the reaction type. The generator is compound wound for a constant E. M. F. (at constant speed) under all changes of load, from no load to 50 per cent overload without sparking. Twenty-five per cent overload can be carried with safety. This Midget set, so called, was designed and constructed by the B. F. Sturtevant Co., Boston, Mass.



STURTEVANT SET FOR TORPEDO BOAT.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

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IN this issue we present a complete report of the proceedings at the Sixth General Meeting of the Society of Naval Architects and Marine Engineers held in New York. The meeting was well attended and carried through with a good deal of professional enthusiasm. As shown by the Treasurer's report the financial condition of the Society is excellent. Applications for membership were very numerous, and by vote of the Society more than fifty candidates were admitted in the several classes of membership. This is a good indication of the increasing interest which is being taken in the higher development of the shipbuilders' art by those engaged in this branch of scientific effort. Doing things because some one did them a generation or more ago is fast getting to be, if it is not already, an unprofitable reason in the drawing room or the yard, and this is true also of acts of omission. Not that any method is necessarily bad or good, because it is old or new: in the past, indeed, it was the genius of American designers that built ships to capture records and have a determining influence on the designs of to-day. The work of the Stevenses, the Ericssons, and the Webbs of yesterday is an incentive to the naval architect and engineer of to-day. But the process of trial and error is not as necessary as is was, for the laws which apply to the construction and propulsion of vessels are better understood and those who study them are better able to take advantage of the certain results than those who have already fixed their horizon of science. To make easy and effective the carrying out in practice of those principles already understood and to develop along scientific lines the points which practice suggests are the chief purposes of such a Society. Its progress and professional prosperity is the index of the condition of the shipbuilders' art in America. There was offered for discussion at the meeting a variety of papers along advanced lines, some of which were suggested by recent naval experiences, and these were supplemented by several excellent topical questions. Owing to the fact that many naval vessels which had seen active service had recently been put out of commission, and their officers widely scattered, the fullest discussion of these matters was not possible. Even in their absence, however, the discussion of such subjects was extensive, and it is likely that the extraordinary interest in matters affecting naval practice, which the war has occasioned, caused a more extensive consideration of naval affairs than usual. And in this also may be found the reason why comparatively little attention was given to subjects relating to engineering pure and simple; a fact which occasioned some comment. A very pleasant feature of the meeting was the excursion to the plant of the Bethlehem Iron Co., at South Bethlehem, Pa., where a most interesting programme had been arranged; all the operations of steel production being shown in succession. This was so successful that it might well become a precedent for similar social occasions in the future.

NOTHING that occurred at the meeting of Naval Architects and Marine Engineers was more timely than the resolution introduced by Lewis Nixon, which will be found in full on another page. There could be no more important subject to engage the attention of the members than adequate provision in construction and equipment of vessels for the saving of life at sea. Mr. Nixon deplored the "lack of appliances" now existing and summed up the situation by saying: "Since the earliest time, so far as I know, there have been practically no advances made in the method of saving life at sea; certainly nothing commensurate with what has been done in other directions." This, of course, is the view from the standpoint of construction, and it is in-

deed to such a Society that shipowner and traveling public alike must look for practical improvements. Meanwhile it is not at all necessary for owners to await action by this or other similar Society to take measures to protect life in the operating department of marine work. Not only is lack of appliances responsible for repeatedly recurring losses of life, and the most responsible too, but lack of preparation is just as apparent. In passenger vessels, those with which we are most concerned here, there are two distinct classes to be considered: seafaring men and landsmen, or passengers and crew. This introduces a complication which does not exist in cargo boats or war vessels. In the liner, therefore, there are three components of this problem, viz., proper appliances, skilled persons to operate them, and unskilled and helpless persons to be saved. Concerning the first the hint given by Mr. Nixon that possibly some portion of the superstructure would be the "ark of refuge" in time of disaster merits immediate practical consideration and study. The ship's boat to-day is a semaphore of helplessness rather than a signal of security. On this and the other subject of properly trained crews to man such contrivances a whole chapter might be written. But here we will allow that the best boats and detaching gear are carried, and that the crew are properly familiar with handling them; but what about the passengers? The invariable attitude of a steamship company towards its passengers is to ignore mishaps, and, should by any chance the question come up, give unlimited and general assurances that accidents are highly improbable, not worth considering, and that the company's ships have a special dispensation from Providence providing for all possible emergencies. Then the statistical mariner talks glibly about the infrequency of loss of life at sea as compared with railroad travel. This is beside the question and all such explanations are mere subterfuges. What matters it to the passenger if no ship had ever gone down before, should it come to pass that the vessel he is on founders in mid-ocean with all on board? Everyone is not a fatalist, though there is an old saying that "if you are born to be hanged you'll not be drowned." From constantly deceiving others the steamship owner comes to deceive himself, until some horrible disaster shocks the world and cuts down profits. There is danger in going down to the sea in ships, lots of it, and of a kind peculiarly impressive to the landsman could he but realize it. It is really childish if not cowardly to ignore it. There is no necessity of going to the other extreme of making the passenger feel that he is participating in the preliminaries to his own funeral when he goes aboard for a voyage. But now, from the time he buys his ticket until he debarks at his destination, the passenger is kept in complete ignorance of possible mishap and preparation for getting away in safety. When a mishap occurs he is panic stricken, not knowing where to turn or what to do, and filled only with a mad desire to go upon deck and worry the already anxious officers with unanswerable questions. In the modern liner with its series of decks and compartments dimly lighted, or in case of mishap possibly not at all, the passenger easily becomes confused, then frantic and when he reaches the deck, if ever, has usually lost control of himself. Though life belts are now provided in every cabin it is not an exaggeration to say that not one landsman in four would know how to fit one on. Passengers, on going aboard a vessel, as soon as possible, should be made acquainted with the location of their cabins relative to the exits to the deck, also how to put on the life belts provided, and also what to do in time of disaster. They should be assigned to stations, to the portions of the deck or boats which they are to occupy, and among the cabin passengers at any rate on long voyages an occasional drill would be an advantage. All passageways and staircases should be plainly labeled, so that the directions on deck and below could be read at a glance. In fact no precaution, however simple, and the simpler the better, should be slighted in providing for the general safety. All the men in the saloon of any big liner are not cowards or incompetents; many would be proud of the opportunity of doing something for the general good, and the aid of even a score of resolute men who had some idea of what they ought to do would be of immense help to the ship's officers in time of disaster. Objection would be raised, of course, that such measures would scare off intending passengers, but it would be better to lose a few that way than lose a whole shipload at sea. In a very brief time passengers would fall in with the reasonable regulations of any company, and in the end the business of a company enforcing such rules would be very materially increased. Managers of theaters are compelled by law to take many such precautions for the safety of their audiences in case of panic or fire.

PROCEEDINGS AT THE 6TH GENERAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS HELD IN NEW YORK.

WHEN President Clement A. Griscom called the members of the Society of Naval Architects and Marine Engineers to order at the opening session of the sixth annual meeting, there was hardly a vacant chair in the auditorium at engineering headquarters, 12 West Thirty-first street, New York. In fact the meeting which extended throughout Thursday and Friday, November 10 and 11, was about as representative a gathering of the marine interests of the country, merchant and naval, as could be got together. So unpropitious was the weather that had the Society been occupied with other than sea interests it is probable the roll of absentees would have been large. But rain in sheets, and wind half a gale, did not even dampen the enthusiasm of the crowd that piled mackintoshes and umbrellas in the cloak room and then gathered in the hall and welcomed the President with a hearty round of applause, while the rain pattered an echo on the skylight overhead.

First on the list of business which preceded the technical features of the meeting, came the report of the Council. This included the annual statement of Secretary-Treasurer Francis T. Bowles, which showed a total membership of 541, made up of: Life members, 6; life associates, 3; active members, 319; associates, 195, and juniors, 18. During the year four members had died and four members and five associates had resigned.

The deceased Members were: Rear Admiral Daniel Ammen, John F. Pankhurst, Charles E. Emery and John H. Dialogue.

Those who resigned as Members were: John E. Jeffries, Arthur Beardsley, John T. Henthorn and Leo Morgan, and as Associates, John R. Bartlett, Thomas J. Allan, Theodore W. Cramp, Albrecht Hesse and Samuel Seabury.

The financial report showed a very sound condition, the balance in bank having been substantially increased. The exact figures were: Balance on hand, November 9, 1897, $2,595.14; receipts during year, $4.728.97, and expenditures, $3,682.48 leaving a balance on hand on November 9, 1898, of $3,641.63.

Secretary-Treasurer Francis T. Bowles now read the list of candidates whom the Council had recommended for election, which included:

Members:—George F. Coleman, with Moran Bros. Co., Seattle, Wash.; Albert Charles Diericx, chief draughtsman American Steel Barge Co., West Superior, Wis.; Albert C. Engard, chief engineer, U. S. N., Philadelphia, Pa.; W. D. Forbes, W. D. Forbes & Co., Hoboken, N. J.; Daniel Edward Ford, assistant general manager American Steel Barge Co., West Superior, Wis.; William E. Keough, consulting engineer, East Boston, Mass.; James J. Killilea, superintendent of construction United States light-house establishment, East Boston, Mass.; John Leonard, passed assistant engineer, U. S. N., Navy Yard, Brooklyn, N. Y.; George Muller, leading draughtsman hull department, Wm. Cramp & Sons, Philadelphia, Pa.; Richard Lane Newman, general manager Globe Iron Works, Cleveland, Ohio; John Platt, Thorpe, Platt & Co., New York; John D. Torrey, draughtsman, bureau construction and repair, navy department, Washington, D. C.; Josiah Wedgewood, manager of drawing offices, Sir W. G. Armstrong, Whitworth & Co., Elswick Ship Yard, Newcastle-on-Tyne, England; Clarence W. Wiley, superintendent engineer, Boston Tow Boat Co., East Boston, Mass.; Frank Willis Grogan, N. A., coast and geodetic survey, Crescent Ship Yard, Elizabeth, N. J.; William Strother Smith, passed assistant engineer, U. S. N., Wm. R. Trigg Co., Richmond, Va.; John Lawrence Frisbie, in charge of construction and repair, Lockwood Manufacturing Co., Everett, Mass.; William J. Wood, N. A., Goodrich Transportation Co., Chicago, Ill.; J. Harvard Biles, University of Glasgow, Scotland; Jarvis Bonesteel Edson, New York.

From Associate to Member:—Henry E. Rottmer, draughtsman bureau construction and repair, navy department, Washington, D. C.; Henry G. Smith, assistant naval constructor, U. S. N., Navy Yard, Brooklyn, N. Y.; William Henry Deming, mechanical engineer and draughtsman, Continental Iron Works, Brooklyn, N. Y.; Albert Lloyd Hopkins, inspector Newport News Company, Newport News, Va.; Axel Gustaf Rossell, chief draughtsman, Wm. Cramp & Sons, Philadelphia.

From Junior to Member:—Sydney L. Wood, draughtsman, superintending constructor's office, U. S. N., Newport News, Va.

Associate:—Walter Aucker, superintendent of floating equipment, B. & O. R. R., Camden Station, Baltimore, Md.; George Crouse Cook, ship draughtsman, Wm. Cramp & Sons, Philadelphia, Pa.; Edwin S. Denise, marine department, Deane Steam Pump Co., New York; William E. Fitzgerald, president Milwaukee Dry Dock Co., Milwaukee, Wis.; Everett G. Haymaker, assistant draughtsman, U. S. N., Bath Iron Works, Bath, Me.; F. D. Herrimann, surveyor general for the Great Lakes Register, Chicago, Ill.; James W. Kellogg, manager marine sales, General Electric Co., Schenectady, N. Y.; John A. Lord, assistant draughtsman, U. S. N., Bath Iron Works, Bath, Me.; Theodore Lucas, calculating draughtsman, Cramps' ship yard, Philadelphia, Pa.; Julius Martin, master electrician, equipment department, navy yard, Brooklyn, N. Y.; Alfred G. Smith, secretary and treasurer, New York & Cuba Mail Steamship Co., New York; Frederick C. Starke, vice-president, Milwaukee Dry Dock Co., Milwaukee, Wis.; Arthur P. Allen, marine engine draughtsman, Newport News, Va.; Frederick S. Brinton, draughtsman, Crescent Ship Yard, Elizabeth, N. J.; Wilson Brown, superintendent, Amboy division, P. R. R. Co., Camden, N. J.; Wallace Downey, Townsend & Downey, Brooklyn, N. Y.; Frederick D. Owen, draughtsman, bureau construction and repair, navy department, Washington, D. C.; George H. Wilson, draughtsman, superintending constructor's office, Columbian Iron Works, Baltimore, Md.

Juniors:—Edwin S. Alexander, ship draughtsman, Newport News Company, Newport News, Va.; William Binley, assistant draughtsman, U. S. N., Newport News, Va.; Almon F. Bowen, draughtsman, Newport News Company, Newport News, Va.; Dean Clark, engine draughtsman, Newport News, Va.; Ernest I. Cornbrooks, draughtsman, Harlan & Hollingsworth Company, Wilmington, Del.; Thomas M. Cornbrooks, draughtsman, Harlan & Hollingsworth Company, Wilmington, Del.; A. A. Packard, draughtsman, Herreshoff Manufacturing Company, Bristol, R. I.; Benjamin C. Fernald, assistant ship draughtsman, U. S. N., Newport News, Va.; M. Hobart McGann, draughtsman, Newport News Company, Newport

News, Va.; Albert L. Swasey, draughtsman, Newport News Company, Newport News, Va.; Edward J. Tuck, assistant foreman, Bath Iron Works, Bath, Me.; Benj. C. Tuthill, copyist draughtsman, U. S. N., Philadelphia, Pa.; William Willis, engine draughtsman, Newport News, Va.; Fred A. Hunnewell, assistant draughtsman, naval constructor's office, Newport News, Va.; H. L. Meeker, Jr., draughtsman, navy yard, New York; Arthur Willey Chase, assistant draughtsman, U. S. N., Newport News, Va.; Charles P. Paulding, draughtsman, W. D. Forbes Company, Hoboken, N. J.

These were voted on *en masse* and unanimously elected.

Here President Griscom yielded the chair to Doctor C. H. Haswell, and the Secretary, by direction of the Council, placed the existing list of officers in nomination with the addition of George W. Dickie, of the Union Iron Works, San Francisco, in place of John F. Pankhurst, deceased. There were no other nominations submitted, and the recommendation of the Council was carried without dissent.

PRESIDENTIAL ADDRESS.

President Griscom having again taken his place in the chair, read his address. In opening he referred to the splendid record of the United States Naval vessels during the past year—vessels which were the product of domestic shipyards. The demand for auxiliary vessels, however, exceeded the available supply of the American merchant marine; the vessels purchased or taken numbering, for both navy and army, about 200 in all, and ranging from yacht to transatlantic liner, had been fitted out for war uses with incredible despatch. Auxiliary vessels rendered valuable service and gave sea experience to a large number of men, which, he hoped, would prove a stimulant to sea employment. Here President Griscom referred to his statement made in 1894, that a modern naval force "could not be produced on the spur of the moment." It was necessary to have an adequate force in peace time, not only for the consequent preparedness, but as a training school for the development of men of the Hull, Decatur, and Farragut type. The full development of a naval force, however, was not possible unless the growth of the merchant marine kept pace. In time of war, too, those nations which had encouraged shipbuilding and shipowning in time of peace, would have a sufficient and well-trained merchant marine to draw upon for material. Since those words were spoken the country had been at war and had found that in order to sustain effectual naval and military operations, not only was it necessary to draw upon the domestic merchant marine, but to supplement this by the purchase of a score of foreign vessels; an act which would have been impossible had not the flag of a friendly nation floated over those vessels. It was not too hopeful, he believed, to predict that one result of the war, the acquisition of distant insular territory, would be an increased activity in shipbuilding, and possibly the turning point from which the nation would regain its onetime rank as a shipbuilding, shipowning, and seafaring people. It was a very happy testimony to the skill of the membership that orders had been placed here by foreign nations for war vessels. Structural material, too, made here, had been shipped to Europe on its merits as to quality and cost. The commercial products of domestic yards during the past year had not supplied all waste, and in addition to this demand there were good prospects of orders for ships for foreign trade. The people were more than ever awake to the value of an efficient navy and had endorsed the present extensive naval shipbuilding programme. In conclusion the President referred to the "gratifying and pleasing field of future activity for the members, involving the solution of many interesting and difficult matters of administration and business, as well as questions of technical importance which would tax their highest ingenuity and skill."

First Technical Session.

President Griscom then announced that the first paper on the programme would be read preliminary to the topical discussion on the same subject, and meanwhile the members would hear the paper entitled:

"THE STANDARD NAVY BOATS."

By Arthur B. Cassidy, Esq., Member.

By way of preface, the author refers to the New England dory, the New Bedford whaleboat, the Ranger boat for naval survey use in Central America, the racing cutter or barge, and the light steam or naptha launch in common use on the coasts, as examples of highly successful craft for special uses. Navy boats have also been designed for their special purpose. Requirements include: Strength to stand hard usage in rough water; stability under sail or oars; great carrying capacity, and weight as light as is consistent with necessary strength. Steam cutters must not only carry their own loads, but be capable of towing other heavily loaded boats. Aboard war vessels stowage space is limited, and the number of boats which can be carried also limited, so that the boats provided may be on occasions very heavily loaded with men, equipments and provisions—as in abandoning ship. Landing parties mean heavy loads, a probable pull through surf, and much banging upon the shore. In 1870 navy boats were classified according to size, but not form, and Chief Constructor Philip Hichborn has completed the standardization. In carrying out this scheme the best existing boats were selected and studied, also opinions invited from navigating officers who held different opinions about the rig. About 75 per cent favored the sliding gunter, and the others preferred the standing lug. The list of boats classified includes: Steam cutters, launches, cutters, barges, whaleboats, gig whaleboats and dinghies. Essential qualities of design for naval boats are: Safety, weight, comfort, and speed, in order. The author comments on each requirement, and gives much practical information concerning materials and methods of construction. In the matter of speed for steam cutters only a moderate rate is sought. In rough waters this ranges from eight knots for 40 ft. cutters to six knots for 28 ft. cutters. There are about a thousand boats in use in the Navy, and the average life is ten years.

DISCUSSION.

Harry De B. Parsons asked what experience had been had with the folding boat in the U. S. Navy. This type was used extensively in foreign navies, and to some extent in the merchant marine.

W. P. Stephens, speaking from the point of view of the yachtsman, said the rigs of the boats seemed small, and it seemed as though the sail area might be somewhat increased to advantage, for the boats were used under sail. In yachting, in work similar to that performed by navy boats, cruising, the yawl rig had been found to be very efficient, with the main sail in the middle of the boat, a small mizzen mast, a short bowsprit and a jib. Sail could be reduced or shipped very readily. The yawl used in yachting could go under jib and mainsail effectively, or even under mainsail, while the navy boats seemed more or less schooner or sloop rigged. Yachtsmen, to get a large area of sail than small size of rig would allow, often adopted the Chinese plan of using several battens to extend the sail and thus get a larger area than would be given by the straight line from clew to peak.

Captain Jacob W. Miller inquired whether any thought had been given to the use of centerboards in navy boats, so as to increase their sailing power to windward. In his experience with such boats as used by the Naval Militia, he found they were magnificent boats in a seaway and in every other respect,

but it was impossible to work well to windward with them.

Colonel Edwin A. Stevens wanted to know whether the use of metal for small boats had been considered, also whether cypress plank had been used instead of white cedar.

Lieutenant W. P. White, U.S.N., called attention to the report of the board of naval boats, which appeared in No. 70 of the Proceedings of the Naval Institute. As to rig, he objected to the sliding gunter rig and cited the case of a boat very fast in pulling races, but slow under sail—sliding gunter rig—when working to windward; going before the wind she more than held her own. He quoted Captain Barker, U.S.N., as an authority who opposed the sliding gunter rig and advocated the lug rig.

W. P. Stephens said a very wide range of experience had been had in canoes and small yachts with sail of all kinds, and the difficulties met with were largely those which attend navy boats. "We want sail that will stow, and that will spread in an area and be generally effective," he said. "We began in canoeing with the low standing lug which Lieutenant White speaks of, but discarded that long ago; also the sliding gunter. A small sail which has found favor is a variation of the sliding gunter, where, instead of the top or gunter being fixed in two irons (as I believe it is in navy boats) to slide, it is fitted so that it can be detached from the mast. At the foot there is a jaw which goes against the mast and slides vertically, and at the top a sling—it can be dropped almost instantly. The boom can be easily detached and the entire rig stowed separate from the mast—a great advantage in stepping the mast. Mr. Herreshoff has introduced a sort of sprit rig, which is a very simple affair and hoists with a single halyard, and as soon as the halyard is started the sail falls instantly. The old sliding gunter seems to be out of date." He then referred to small boats for yachts, to which very little attention had been given. The average yacht boat lacked displacement, had considerable rise of floor and of sheer, with a low waist, so that in the trough of the sea she rolled badly. There was room for much improvement in this direction.

Naval Constructor John G. Tawresey, U.S.N., replying in the absence of the author, said that though the Navy boats had been standardized, the work had not stopped, for, though the dimensions and form were fixed, the boats were being gradually improved. Navy boats were subject to very rough usage. Boats on board ship were usually carried close to the smoke-pipes, where there was great heat—the boats were built of wood. Hoisting took more out of the life of a boat than any other one thing. If scantlings were proportioned so that boats would not be strained in hoisting the boats would be enormously heavy. The blast of guns often seriously damaged boats. That Navy boats are held in high esteem by Navy men was shown by the orders sent in from the various auxiliary craft during the war for standard Navy boats. In response to the questions asked, he stated: Folding boats had been experimented upon in the Navy and reported on unfavorably. As to metal various metals had been tried and aluminum investigated. Some years ago iron and steel were used for steam launches and found to be unsatisfactory. The wooden boat was considered all around the best, but it should be recollected that the Navy boat was not put in the water in the spring and taken out in the fall, but was continually in and out of the water, and the bottom was always accessible. In former times the outside of boats was coppered, but this was abandoned as unnecessary. As to the centerboard, this was simply a question of weight. A boat could be built strong with a centerboard, but that would increase the hoisting strains. The Navy boat was not built as a sailing boat, but for all around use, and the constructors recognized that they could be built much better for sailing exclusively. He replied to the criticisms about rig by making a comparison with the case of a commanding officer of one of the single-screw U. S. corvettes, who complained officially that the boat did not sail as well as the famous ship Constellation. The present rig suited three men out of four, and it was not likely that a rig could be found which would satisfy the fourth man.

The Chair called upon Captain W. C. Wise, U.S.N., for an expression, and this officer briefly replied, expressing his preference for the French lug, which his experience had shown to be the best for safety, convenience, and period of lowering the sail and making sail, and also for carrying capacity.

BILGE KEELS AND ROLLING EXPERIMENTS—U. S. S. OREGON.

By Asst. Naval Constructor Lawrence Spear, U. S. N., Member.

This paper is of an extremely technical character, narrating the results of experiments made with U. S. S. Oregon—before and after fitting her with bilge keels—and then recounting the generally accepted assumptions and theories pertinent to the case, which have for their object the evolution of such formulæ as would be of practical value to the designer. The original designs for the battleships Oregon, Indiana, and Massachusetts called for bilge keels; but during the construction of these ships it was decided to omit keels, to facilitate docking. Sea experience, however, "demonstrated the desirability of some steadying influence." The actual maximum inclination of the Oregon "probably" never exceeded twenty-two degrees—the deck edge goes under at eighteen and a half degrees. This angle was reached while the ship was at anchor in Drake's Bay, subject to a long low swell, with a period approximating closely to that of the ship. The vessel was immediately gotten under way. The angle of heel was inferred from clinometer observations, which, says the author, are notoriously inaccurate. Subsequently the vessel was docked and bilge keels fitted. The "Oregon's" keels are 34 in. deep near the edges, tapering to 14 in. amidships. The vessel was rolled both previous and subsequent to docking under substantially the same conditions of stability and trim. Without keels the mean period for a single swing was 7.6 seconds, and with keels 7.83 seconds—an increase of a trifle over three per cent. Trials were held in slack water, no current, vessel moved to buoy, wind negligible. The "extinctive effect" of the bilge keels plainly stated is: U. S. S. Oregon, starting at an inclination of six degrees to the vertical, required, without keels, sixty swings to reduce to an inclination of two degrees, while with keels the corresponding extinction required only ten swings. Under way the effect of bilge keels would be greater. In discussing results the author states the belief that the extinctive work done by bilge keels comes under three main heads: (1) Increased wave-making resistance; (2) Disturbance of natural stream line motions about the ship; (3) Direct resistance of plane surfaces of keels. Though there is yet no data upon which to base a quantitative division of the total resistance between these three heads, the third can be easily shown to be a comparatively small factor. The author makes a comparison between the Oregon experiments and those conducted by the British Admiralty with H. M. S. Revenge.

In the absence of the author, W. F. Durand read this paper.

DISCUSSION.

Naval Constructor John G. Tawresey, U.S.N., in opening the discussion, said: "In the early part of this paper the author speaks of the practice of omitting the bilge keels from the larger battleships. I would like to say in relation to that practice that the

arguments advanced to justify the practice did not by any means receive the approval of professional men generally. At the time this question came up the question of the resistance to the rolling of the ship had been pretty thoroughly investigated. Resistance had been parceled out under three heads, the skin friction, the direct head resistance due to deadwoods and projections of that kind, and wave-making resistance, and it had been fully established that the wave-making resistance constituted by far the larger part of the resistance to rolling. In addition to that there had been experiments demonstrating the effectiveness of bilge keels. They had been tested and tried; and in the face of all that it is rather remarkable that any one should take an equation representing the effect of the bilge keel and ascribing the entire effect to the head resistance, the movement of the bilge keels sidewise through the water, and arguing from that action deduce that the relative effect of a bilge keel on a large ship like a battleship was comparatively small. If the entire effect of the bilge keel had been due to the head resistance, as assumed, that position would have been entirely correct, and the keels would have been relatively ineffective on these large ships. But it is well known that one of the principal methods used to generate waves in oil tanks and other places for experimental purposes is by oscillating a plane surface normal to itself, and it is rather remarkable that that should be overlooked. I think we have got to seek the true reason for the omission of these bilge keels, not only in our own service, but abroad, in the question of docking." Mr. Tawresey then referred to the author's printed paper, took exception to a statement which attributed the extinctive work done by bilge keels in part to the "disturbances of natural stream line motions about the ship." In the speaker's opinion, a very small part of the resistance came under that head. He referred to Mr. Froude's experiments on the Greyhound, which showed that after allowing for the skin friction, due to the increased surface of the ship when the bilge keels were added, the resistance to the motion of the ship through the water was not greatly increased by the bilge keels. If the stream lines had been radically disturbed by the addition of bilge keels the effect would have been observed in the increased resistance to the propulsion of the ship.

Naval Constructor Francis T. Bowles, U.S.N., referred to missionary work he had done several years ago on the subject of bilge keels. The result was they were fitted to nearly all the larger vessels and did their work very satisfactorily. "When it came to the building of battleships," he continued, "we had got so accustomed to bilge keels that it seemed as if we might leave them off, especially as they interfered with going into dry dock. Now, as a matter of fact, the very first experience of those ships at sea showed that they were not safe without bilge keels. I venture to state that no one will ever again attempt to build a battleship without a bilge keel, no matter if it is necessary to build a new dry dock."

Assistant Naval Constructor R. M. Watt, U.S.N., said the actual time consumed at the Brooklyn Navy Yard in fitting bilge keels to the Massachusetts, under the direction of Mr. Bowles, was sixteen and a half working days.

PORTABLE PNEUMATIC RIVETERS IN SHIPBUILDING.

By W. I. Babcock, Esq., Member.

This paper embodies the experiences of the Chicago Shipbuilding Co. during three years of constant experimenting with machine riveting. As a result the company is now able to drive every rivet in a ship by power machines, operated by unskilled labor, and in the last ship built about 250,000 rivets were so driven out of a total of 340,000 rivets. At the outset a stationary steam riveter had been used driving 1,800 rivets in ten hours, at a cost of not over half a cent apiece, a saving of 2 1-4 cents each over the scale for hand work. For portable machines compressed air was decided upon in preference to hydraulic power on account of severe winter frosts, and because the air could also be used for caulking and chipping hammers, drills and reamers. After describing the various types of tools employed, and the rigs needed to keep them up to their work, the author states that the quality of the work done with these tools is admitted by all inspectors to be first-class in every respect, and "far better and tighter work" than those driven by hand. As to cost, adding air, repairs, etc., the saving is from one to two cents per rivet over piecework, prices for hand work depending upon the location in the ship and averaging 1 1-4 cents. In the ordinary lake steamer of 4,000 tons the saving is from $4,000 to $5,000 over hand work.

DISCUSSION.

R. L. Newman, of the Globe Iron Works, began the discussion by stating that during a like period his company had been making similar experiments with equal success. On the revenue cutters Algonquin and Onondaga the bulkheads were riveted up by pneumatic hand tools to the entire satisfaction of the Revenue inspectors. At the outset he had tried riveting the shell with a pneumatic riveter, and after driving the rivet, endeavored to mill it off. Many rivets so treated were not tight, and it was found necessary to set down again with a hammer—three operations in all. The result was that the saving was not more than 25 per cent over hand work. He believed that in the future for countersunk shell riveting a frame would not be used, but the work done with a heavy hand tool, using the ordinary holder on, and finishing with the pneumatic chipper, and finally the hammer.

John Platt, referring to Mr. Babcock's reference to hydraulic riveters, said he had experience in this direction. "It seems strange," he said, "to one who has had connection with English yards for the past fifteen years and has known the kind of machinery in use there, to find people commencing again to take up riveting with a hammer, and simply using the blow instead of the steady pressure, that has been considered so very necessary by all inspectors and shipbuilders abroad. As a matter of fact, in the larger work it would be utterly impossible to do what has been done here. If Mr. Babcock had to deal with 1 1-8 in. and 1 1-4 in. and larger rivets, it would not be possible to fill the holes properly. About shell plating, I might refer to the work done in the last year at Harland & Wolff's Works, at Belfast. We there erected for them an immense gantry, which spans the whole shop. The crane is of the general construction of the one in use at the Union Iron Works, and this travels up and down the whole length of the shop. The riveters are carried on special cranes, which travel to themselves up and down the runway. These machines have about 6 ft. or 7 ft. gap, with 40 to 50 tons on the rivet. This apparatus is designed for the building of the Oceanic, where it was absolutely necessary to go into power riveting. In England or Ireland they would take up hydraulic riveting because that is one thing that they have had very much experience with, and they are satisfied with it. The question of cost does enter into it, but not to a very great extent. There are hydraulic riveting plants working in Canada and the north of Russia, and they use a certain amount of crude glycerine in the water and have no trouble at all. It has been said that the big riveting plant at Harland & Wolff's is not an economical one, but within the last three months they have ordered a duplicate plant, after working the other a considerable time, so they must be satisfied with it. On the smaller work it does seem to me that very good work can be

done in the way suggested here. It would be interesting if Mr. Babcock would tell us the largest rivets he has driven and what experience he has had in trying the driving of rivets of increased size."

Naval Constructor John G. Tawresey, U.S.N., said in his experience of several years with pneumatic tools in ship work he had found that they worked economically, rapidly and thoroughly. "There is one drawback," he remarked, "in connection with the working of pneumatic hammers and riveters generally, and that is the infernal racket that they make and the general demoralization of the nerves of every one in the neighborhood. I have no doubt that that increases somewhat the cost of the work around it." He inquired of the previous speaker as to the proportions of glycerine and water used in cold climates.

Mr. Platt replied: "One-third glycerine and two-thirds water. They use common crude glycerine."

L. R. Pomeroy suggested the question, "What are the limitations to the use of pneumatic riveters?" A large number of locomotive builders had gone extensively into the practice of riveting up boilers with pneumatic tools and had abandoned it, because they could not make tight joints. Such tools were only used now on foundation rings or tank work. The explanation given was that the air was too elastic, whereas with hydraulic power a constant steady pressure was secured, and there was not the same difficulty of leakage as a result.

Mr. Babcock, replying to the queries, said, one inch was the largest size of rivet driven by pneumatic hammers in his yard. In bridge shops and in building gasometers larger tools were used and inch and a quarter rivets driven. There was no reason why a 2-in. rivet could not be driven with a sufficiently powerful hammer. The pressure of air at the tool itself was of the greatest importance. This should not be less than 100 pounds. With a new compressor building at the Chicago yard he hoped to get 125 pounds, and expected to be well repaid for the additional outlay necessary. The reason pneumatic hammers were liked better than hydraulic compression riveters was because they could be handled so much more easily—by hand, in fact. The gantry crane at Harland & Wolff's was an extremely expensive construction and practically its only use was to handle the heavy riveters. The same work could be done here with pneumatic riveters, any one of which could be carried about by two men. Noise was an objection, but not so bad that it would cause riveting to be stopped. As to the limitations on the use of these tools there was none, provided suitably designed apparatus was used. As to the question of cost, he believed that the Chicago yard was the only one having a machine for shell riveting. In the last ship built there, 51,306 shell rivets were driven by hand, piece work, at an average cost of 3.99 cents apiece. With the pneumatic shell riveter 74,493 rivets were driven at an average cost of 2.96 cents per rivet. This figure represented the direct cost—not including the cost of air, repairs, etc. The shell riveter was developed in the shop during the building of this ship. After the keel of the ship had been laid and the first machine put to work every hand riveter in the shop went out on strike, and stayed out eleven weeks. Then the company built twelve more machines and put new men to operate them. In future work he hoped to reduce the cost per rivet. He did not believe it possible to drive shell rivets by a heavy hammer held in the hand. The whole matter, however, was in an experimental stage, the shell riveter having been developed within a year.

Second Technical Session.

Vice-President Edwin A. Stevens called the members to order at 2.25 o'clock, at the opening of the afternoon session. He announced that Captain W. H. Jaques would exhibit stereopticon views of submarine boats, with a brief descriptive talk. The powerful electric lantern was then brought into use and views of various boats, both in the water and out, were thrown on the screen. These included the Spanish boat Peral, the Nordenfeldt boat, and both the U. S. boats Holland and Plunger. He referred briefly to the various trials made with these boats, at home and abroad, and spoke with enthusiasm of the future of the submarine boat. A vote of thanks concluded this interesting feature and the members gave attention to the reading of the paper on:

TORPEDO-BOAT DESTROYERS.

FOR SEA SERVICE.

WITH SPECIAL REFERENCE TO THE CONDITIONS THAT PREVAIL ON THE PACIFIC COAST.

By G. W. Dickie, Esq., Member.

In opening the author refers to the materials for opinions and possible changes of practice that the recent naval operations have provided. In the torpedo-boat destroyer sea-going and sea-keeping qualities should be of first importance, and also high speed and battery power. The present destroyer is up to requirements in the matter of speed, but only for a short time in smooth waters, and speed has been made paramount to all other qualities. Conditions peculiar to Pacific coast service include, long distances between harbors and rough water along the coast line. The author believes the 420-ton destroyers are a "decided improvement," but not up to Pacific coast requirements. Annexation of Hawaiian Islands requires greater radius of action for such vessels. He suggests a type of vessel 250 ft. long, 800 tons load displacement, with trial speed of 25 knots and radius of action at 12 knots of 3,200 knots. The design gives good berthing space and quarters, capacity for 200 tons of coal, an armament of six 6-pounder guns and two 4-in. rapid firers, and considerable protection by 1 in. nickel steel. Under water torpedo tubes only are recommended. Such a boat should be capable of full speed on a spurt, and be perfectly seaworthy, and available as a despatch boat or scout as well as a fighter.

DISCUSSION.

John Platt, in opening, said: "I take it that we can discuss the boats, with respect to sea service on any coast, without limiting it to the Pacific coast, and I shall speak of it in this connection. I take exception to the way in which Mr. Dickie has treated this subject. I fully agree with his ideas with regard to the boat which he describes, but I think that he is classifying it in the wrong class and that he has not treated it just fairly and right. The boat that he has described, I think, would be better classed as a torpedo cruiser or torpedo gunboat—not as a destroyer. I think I am right in saying that in 1890 the Department in Washington designed a boat, which they called a torpedo-cruiser, and which was about the size, or maybe a little larger, and about the same speed, but which unfortunately was never built. From what Mr. Dickie says here, and from what has been reported to us from the war, it is very certain that such boats should be built. Mr. Dickie describes an ideal torpedo-boat destroyer, and one of the things he says are necessary is the highest speed possible, so that they can overtake a torpedo boat. There are very many torpedo boats that are over 25 knots, and the limit of speed of his boat to start with is 25 knots. Of course, there is good reason for that. Then he says that it cannot be said that the present type of torpedo-boat destroyer comes near these requirements andthat quite a number of destroyers now meet the requirements in matter of speed if required for a short time, in smooth water only. I made runs last year in one of the standard British destroyers—a 30-knot boat. It is a standard 300-ton British destroyer. The first day we went out to make the runs there

was quite a heavy sea on; in fact, so heavy a sea that it was not possible to complete the contractor's trial. But they ran the three hours' run, so that they could get some results from it. The wind was blowing enough, and there was enough of a sea on to knock down the speed when we were running against the wind to about 27 knots, and when we were running with it, up to 32 knots, and the boat maintained this for three hours, making that variation, depending on which way she was running. The same boat I went on quite a number of times, and in moderate weather there was no difficulty in maintaining the speed of 30 knots for three hours, and we did it continually. Then Mr. Dickie says: 'The quality of speed has been made paramount to all other qualities to such an extent that the full speed can only be reached when the conditions are such that the sea-going qualities can be neglected.' That is hardly true of the present class of British destroyers, because they do run at their full speed for three hours, which is not a short run, and do that repeatedly time and again. To illustrate it, we were out on the Mallard, off the Nore. The torpedo-destroyer Fame was at Sheerness. She was then being put in commission, and she was given a commissioning trial, and she went out of the harbor while we were there. She had a deckload of coal, and she was in charge of the Navy entirely, and she ran out, and they ran her for an hour, and when they came back the captain reported that they had made 29 1-2 knots under those conditions. So that in the British practice certainly, in one or two classes of boats, other qualities besides speed have been given the very greatest consideration. Speaking of speed, there they have to obtain that speed on a given coal consumption. The maximum coal consumption is 2 1-2 pounds per horse power, and when they are burning from 60 to 80 pounds of coal per square foot of grate that is something they have to build a good boat to be able to do. As a matter of fact, in the recent trials, in quite a number of them, the consumption has varied in Thornycroft boats between 2.02 pounds per horse power and 2.15 on all these trials of three hours duration. He speaks of the 420-ton destroyers lately ordered by the Government as being a decided improvement over the others. On the lines on which he is considering the matter, they undoubtedly are. But it is a question whether as pure torpedo-boat destroyers they are any improvement at all. Torpedo boats, as he says, operate from harbors and inland waters. Torpedo-boat destroyers, of course, have to travel with the fleet. But when they are traveling with the fleet they have not to make any such speed as 30 knots or anything like it, and they travel with the fleet at the ordinary speed and are able to keep up that speed, and then when necessary they can make their bursts of speed, and have a faster speed than the torpedo boats. Take a boat of the 300-ton class. Such a boat is 210 ft. to 215 ft. long, and some of these other boats run to 230 ft. or 240 ft., with an extra two feet of beam; and providing they run on an even keel, which they are designed to do, they are still good sea-going boats, and as destroyers are perfectly useful and good. The larger boat which he describes here is practically such a boat as H.M.S. Speedy, which was one of the first torpedo gunboats built on the other side. It is not nearly so fast as these two, because at the time that was designed there was not nearly as much experience in making and building these boats. But she made 22 1-2 knots. I speak of that here because Mr. Dickie speaks of the expert management, with special trial trip crews and all such things needed to make speed under such conditions. She developed 4,700 H. P. on her trial. In actual service conditions, since that date and to-day, she develops 5,000 H. P. whenever required, and can do that easily.

Stevenson Taylor: "I would like to ask Mr. Platt how the speed of the Fame was determined. You refer to the Fame having made, under extraordinary conditions as to loading, etc., a speed of 29 1-2 knots. That is to say, the captain reported that she made that. As a rule, the speed reported by the captain is very much in excess of the actual speed of the boat, so I should like to ask him how that speed in particular was determined."

Mr. Platt replied: "In the English service all speed on trials are determined by six runs over the measured mile, that forming part of the three hours' run. They run between points, and on those three hours they are able to standardize the screws and find out just how many revolutions give a certain speed. Those boats are fitted with proper arrangements of counters for the total revolutions and all such things, and those remain there. In the run on the Fame they took the revolutions from the counters and with the data obtained, not from just one run or two runs, but several runs in the different stages of the trials, they were able to determine very nearly what the speed was, and I think the actual speed, too."

FIRST TOPICAL DISCUSSION.

The Chairman now announced that the first topical discussion, "The Utility of Torpedo Boats, and Has the Submarine Boat a Place?" would be taken up in connection with Mr. Dickie's paper.

Secretary Francis T. Bowles explained that the Navy Department had recently put out of commission all the torpedo boats and consequently the officers who had served in these boats were now widely scattered and unable to attend the meeting. He then read written communications from officers on the subject, which were chiefly criticisms of present conditions. Among the defects in our system pointed out were the multiplicity of types of boat and lack of homogenity, the lack of specially trained crews and inadequate facilities for taking care of boats in peace times. These papers follow:

TORPEDO-BOAT UTILITY.

BY LT. COM. W. W. KIMBALL, U.S.N.

After the experience of the China-Japan war, in which torpedo-boats played the most important and effective roles, after the experience of the Spanish-American war, in which torpedo-craft caused more apprehension and more radical departures from accepted methods of naval warfare than all other craft employed; after these late experiences there can be, in an assemblage of people interested in naval architecture, no question as to the utility of torpedo-boats, considered as a general proposition. In all foreign navies worthy of the name, the tactical place of the torpedo-boat is well defined and the great usefulness of her enormous power within her limited field of work, is as well understood as are the characteristics of any other type of fighting craft; and yet we, the people of the United States, and we, the people of the United States navy, the majority of us, at least, do seriously question the utility of the type.

The reason for our unique attitude in this matter of torpedo-boats is readily understood when we contemplate the determining conditions in our country, all of which are more or less familiar to the members of this society, but a few of which I would venture to recall to your remembrance: First, we have never approximated to any policy in torpedo-craft design or building program, as is apparent from a glance at the displacement column in the navy register; second, we have the vaguest notions as to design and requirements of torpedo-boat machinery as is shown by a comparison of the displacements and horse powers of our boats; third, we are at least fifteen years behind the civilized world in our ideas as to the conservation of the material of our boats, as is shown by our laying them up and hauling them out of water, a process that has long since been given up by people who have tried it, because they have found that nothing causes more

rapid deterioration; fourth, we have only a small, very small, personnel competent to handle torpedo-boats, and this small trained personnel we do not at present propose to increase, or even to utilize as a nucleus for the organization of the crews of the new boats that must soon be received from the builders and put in commission; fifth, we have only very few officers of the engineer corps competent to give experienced trained engineering supervision to those repairs on torpedo-boats, which are attempted at navy yards, and those few are rarely available for the duty; sixth, we have never attempted a real torpedo-boat attack drill, and consequently have no experiences to aid us in deciding upon the tactical value of the craft. This list of a half-dozen well known determining conditions of our torpedo-boat service could readily be increased three times by the enumeration of other equally important factors in the case; but it would be idle to do so since the list as it is, gives ample reason for questioning the utility of torpedo-boats in the United States.

I will venture the opinion that, in time, some of these conditions will be modified; it seems to me that they must be for the following reasons: First, if we are to ever have use for a navy of fighting ships we must have an efficient torpedo-boat service to supplement the fixed coast defenses, or our fighting ships will surely be deflected from their legitimate off-shore work to the in-shore defense of our ports and coasts; second, from the extent and condition of our attackable coast, and from the fact that torpedo-boats are the only craft (bar armor-clads) that can check raiding armor-clads, we should lead the world instead of lagging behind it, in the development of torpedo-boat efficiency. When these facts become sufficiently familiar we may begin to utilize the heterogenous lot of boats now built and building, and may then become impressed with the necessity of systematizing designs and types.

As we will never possess enough torpedo-boats to cover our extensive coast properly, we should strive to develop that design which will best allow our boats to concentrate at and work from any base temporary or permanent, between Eastport, Me. and Galveston, Texas. Such a design combining sufficient torpedo armament for use against ships, sufficient gun armament to give the boat a fighting chance against a hostile destroyer at night, sufficient speed, endurance and sea-going qualities, can readily be worked out upon a displacement of 120 to 150 tons, providing we bear in mind the facts that we must, for lack of shore bases, furnish depot ships, or floating bases for the support of the boats, and providing always, that we obtain a clear idea of what we intend the boats to do, and then try to learn how they should best be used for the intended purpose. The true base boat, the 100 footer that we have tentatively attempted to develop, is too much of a luxury for us to consider until a real torpedo-boat service has been established. The line of demarkation should be sharply drawn between the torpedo-boat intended primarily for the defence of ports and coasts against ships, and the destroyer primarily intended for the defence of ships against torpedo-boats—between the boats of 120 to 150 tons and the destroyer of 400 to 500 tons.

It has been borne in upon us in the navy that the only way to do good gun-work is to get the best guns and then learn how to shoot them; but we are apparently utterly unaware of the more important fact that the only way to do good torpedo-boat work is to get the best boats for our purpose and then learn how to use them. If the navy axiom "the only way to learn how to shoot guns is to shoot guns" be true, how much more then by the course of sufficient reasoning is it true that, the only way to learn how to use torpedo-boats is to use torpedo-boats, since the shooting of guns is so much simpler a matter to learn than is the proper utilization of torpedo-boats. If in the future we shall learn to utilize proper torpedo-boats properly, we will then know, as people in foreign services now know, that the feat of the Dupont in making 12,000 miles of deep sea work during the late war and turning up with her machinery in good condition after it, was, in an engineering sense, more remarkable than the Oregon's run around the continent and reaching Key West with her machinery in good condition. We question the utility of torpedo-boats because we do not know how to utilize them.

TORPEDO AND SUBMARINE BOATS.

BY LT. A. P. NIBLACK, U.S.N.

The torpedo boat has not many friends in the United States, either in or out of the navy, and this, too, in spite of the recent improvements in torpedoes, by which their efficiency has been increased at least 100 per cent. The Obry attachment has made possible an absolutely safe and accurate underwater discharge, as well as a deadly accurate discharge. We have no torpedo boat history. Other countries have gradually developed a system. We have jumped into the middle of it. We are beginning at the top, and our policy is very unstable and wobbly, because nobody really knows very much about them. Many very estimable people think they go under water.

During the war this summer it was found necessary to use the torpedo boat on dispatch and blockading duty. No one can deny that most of them did their duty well, considering that they were not designed originally for that purpose. We are not willing to accept the lessons taught us in Europe, where everything is worked out thoroughly, and where all we have to do is to read and learn. We must have our own costly experience, and we are calmly proceeding to make every mistake possible, and in four or five years we will be where some navies are now, but with our methods we will always be behind. The outlook is not encouraging. We have almost no trained officers or men. Some pressing necessity has driven the Department to putting our boats out of commission. This means not only a loss in training, but a deterioration in material, because the method of laying up is open to the objection that it is contrary to accepted methods abroad. Even if it is successful there is no need to experiment.

In Norway, Sweden, Denmark and Austria, boats are hauled out of the water under sheds in the winter season. In the northern countries it is on account of the ice, but more especially because there are no crews available, as conscription is only for six months in other than the winter season.

In Austria all the boats are at Pola, and in winter are hauled out under sheds only because of the heavy gales and because money is not available to construct a basin in which to moor them. The Austrian officers disapprove of hauling boats out. The say it causes a loss of speed to the boat of from one-half to one knot each time it is done, and injures the hull and machinery. Of course, we may be able to haul our boats out without injury, but the cold will hurt them.

In Germany the boats stay in the water always, except when periodically docked or under repairs. In winter steam heat is kept on them constantly, the steam heating pipes being connected with a boiler on shore, or else to an old torpedo boat or hulk used only for this purpose. They regard a torpedo boat as a delicate instrument, and yet they go to the extreme of sacrificing speed to strength. Their boats are all single screw, but they have a bow rudder in addition to the after one, which makes them handle as well as a twin screw boat. The bow rudder may be raised or lowered at will. Even with our twin screw boats such a rudder would be most acceptable.

Boats in commission in Germany are available for war in the time it takes to coal and provision and get a few explosive fittings carried only in war (for

countermining, etc.). Boats in the first reserve have their men and all stores aboard, except war heads and explosives. The crews live on board station ships adjacent, and boats of the first reserve are ready for war in six hours. Boats in the second reserve have their stores in an immediately adjacent storehouse. Each boat has its own separate building. They can be ready for use in forty-eight hours, or in time it takes to call in the crew from civil life. All fittings of boats are absolutely standardized, and in the group built at the same time the parts are interchangeable. Their store system is ideal. We could never approximate to it in a hundred years, and we are getting away from standardization as rapidly as the different private firms can drag the Navy Department into permitting it. Our steps are all rapidly backwards.

Our store system is so onerous that in putting the Winslow out of commission some days ago, and having unusual assistance in trying to make a record, it took seven days to lay her up. I have no idea that in April, when the boats are to re-commission, they will really be ready for sea inside of a certain number of weeks, and with all the care given to the engines in the way of red and black lead, tallow and vaseline, I doubt if they can be put in running order short of several weeks. Meanwhile, in the case of war, where are we? Of course, there is no danger of war. There never is until it comes.

It has been my personal good fortune to see practically every torpedo boat in four or five foreign navies and to study the various types somewhat superficially. I unhesitatingly give it as my opinion that the Dupont, Porter and Morris, built by Herreshoff, are the three best boats of their type in the world, and that there are very few poorer ones than the Foote, Gwin, Rodgers, Winslow, and Ericsson. Herreshoff is as much a master in boat building in general as Edison is in the field of electricity. The engines of the Dupont are as distinctly superior to those of the boats above mentioned as a Blake pump is to a handy billy. I don't say this in criticism. It is only grief that Herreshoff does not build all our boats, or that we do not copy his models and fittings.

Germany is where she is because Schichau has built all. The standardization is perfect. We have an assortment of boats coming on now running the gamut in displacement, horse power and type, till one is forced to the conclusion that there is no recognized relation between horse power and displacement, nor anything but a belief that any 1 H. P. shop building establishment can build a modern torpedo boat, or any engineer or constructor design engines and hulls. Personally the outlook is to me very gloomy, and probably it is just as well that I am to temporarily sever my connection with the torpedo boat service during this, the teething period, when all of us are learning things.

If we consider the mechanism of a Whitehead or Schwartzkopff torpedo, we will find that all the remarkable things which it does may also be done by a submarine boat. In the torpedo the opening and closing of valves, the regulation of depth, the steering, the various safety devices and the length of the run are all automatic. In a submarine boat these corresponding things are regulated by hand. There is no real reason why the submarine boat should not be as successful as the automobile torpedo. Its speed is not and need not be so great, but there is no problem connected with it which has not been solved.

We have in the Holland boat a combination of the elements of success. Along its lines we are sure to get the best results. As more experience is had the submarine boat will take its place as a disturbing element in the plans and operations of war. The Holland boat is a distinct success, and I hope will be purchased by our government. There is one difference between a submarine boat and a torpedo, which is very important. In the torpedo all gearing is oiled automatically, and a torpedo may lie idle six months or more, with no deterioration. With the submarine boat the care of all the rather delicate apparatus or mechanism must be unremitting and tireless—much more so than in a torpedo boat, which is difficult enough. There is another feature of submarine boats in general, which has to be considered. If a propeller fouls a buoy rope or chain or mooring when the boat is under, it is "all up" with the crew, because there is no way of getting out to clear it. I understand that in the boat building at Baltimore the government requirements were so difficult that it was necessary to give her five propellers—five vulnerable points, and five chances for trouble. No one can blame the designer for this, but the propeller question is easily solved by having as few as possible and having those guarded. I made a trip in the Holland boat, and everything worked perfectly. The sensation of diving is a little unusual—otherwise it is rather tame sport compared with a torpedo boat at high speeds. There is no reason to consider the submarine boat as dangerous. It can be made almost absolutely safe. Indeed, in war it has many more chances than a torpedo boat, but its crowning virtue is that it makes blockading almost impossible, and strategically in war has a place all to itself.

TORPEDO BOATS IN ACTION.

BY LT. WILLIAM L. RODGERS, U.S.N.

In the recent war the Spaniards were unenterprising, and the Americans had no opportunity, so torpedo boats did not use their torpedoes, and the public seems to have jumped somewhat hastily to a conclusion that the war has discredited these crafts. One might as well think that armored cruisers are discredited because the Spanish ones accomplished nothing. In order to show how erroneous are the opinions now popularly current in regard to torpedo craft, the nature of the torpedo must first be understood as well as the limitations which its characteristics impose on the employment of the boat; then the boat itself may be considered.

Before going further I would like to call to mind a fact which naval architects too frequently overlook in discussing naval design. This is that mechanical and architectural improvements are valueless unless they confer desirable, tactical or strategic advantages in due proportion. This observation applies with particular force to the question of speed, of which the importance seems to be overestimated on many occasions. Perhaps this is because of all nautical and tactical qualities, speed alone can be measured absolutely. Thus in the consideration of rival designs it appears with singular advantages over other features, whose tactical importance is not less, although less easily demonstrated. But to return to the torpedo. Briefly, the torpedo is an automobile submarine boat, weighing 850 pounds, and carrying a cargo of explosives. It is launched by a very small powder charge, and in launching it takes a deep initial dive, after which the depth regulating gear brings it to the desired depth. Until recently it has been without inherent directive force, and its course, after discharge, was influenced by the speed of the boat firing it, as well as by the chance of the wave surface as it enters the water. Its maximum speed has been 30 knots, and its range at that speed about 400 to 500 yards.

Now note how all these peculiarities affect the tactical employment of the torpedo boat. First, although the boat runs at a depth of from 5 to 15 feet, the torpedo dives deeper than that when leaving the boat, and there is risk in hitting the bottom in less than 30 feet, the risk increasing with diminishing depth. Thus the torpedo cannot be fired when the boat is in shoal water. Then rough seas make its course erratic,

although a new device, soon to be issued to our service, diminishes this source of error. Finally the speed of the torpedo is not superior in any great ratio to that of ships, so that the man firing must make allowance for the speed of the target at the instant of discharge. An error of only two or three knots in his guess will cause a considerable displacement of the torpedo on the target. At 500 yards range an error of three knots in his guessing the speed of the enemy will cause the torpedo to miss a 300-foot ship. Thus the boat must be within 400 yards before she can begin to fire with any reasonable expectation of success. At the same time the commanding officers will feel disposed to fire the instant the enemy opens, on the ground that a chance shot at long range is so much, and if one waits for closer range the torpedo may never be fired at all.

Taking up the subject of the boat itself, we have great engine power in a small displacement, and consequently machinery so light and frail that after every hard run it is necessary to lie by for a little while and tune up again. Moreover, the quarters for the men are small, and hot in summer, and cold in winter, making life impossible for long periods of active work. Those who maintain that men can become accustomed to the service lack experience. It is simply impossible for a crew numbering only twenty men to maintain itself on blockade duty for long periods in a topedo boat without gradual deterioration of health, and a large sick list following any unusual exertion. A minimum crew of thirty-five to forty is needed for continuous service. Further it must be recollected that owing to their small size torpedo boats cannot maintain their nominal speed except in the smoothest seas. A gale which would cause a great Atlantic liner to slow down one or two knots would make the Dupont slow from 20 to 25 knots below her trial speed.

The field for torpedo boats is clearly indicated by these considerations. Properly the boat is almost as purely a weapon for coast and harbor defense as a gun mounted on shore. Although it is possible to use it for distant service, it should be kept in port, ready to rush out upon an attacking enemy when circumstances are favorable. But the fate of the Spanish boats at Santiago and San Juan show that a day attack is almost hopeless. The torpedo boat should therefore be small enough to depend largely upon invisibility at night. As for speed, it should not be excessive, but we should seek rather somewhat greater solidity in the machinery, especially in the auxiliaries, together with boilers giving steam somewhat excessve for the engines. All machinery, I think, should be in duplicate, including boilers, engines, all auxiliaries, and also the main steam piping. All auxiliaries should be independent of the main engines. Twin screws are desirable for the sake of reduced draught and precision of manoeuvering, although the single engine has certain good points. As for speed, it seems to me that 22 to 23 knots, or that of the fastest cruisers, is ample. Any greater speed can so seldom be used on the open sea, that it is not worth the necessary sacrifice. Upon this point it must be recollected that in delivering an attack by night or in thick weather, a speed of 10 or 12 knots only would be used. Greater speed might cause a marked bow wave, and occasional flame from the smoke-pipes, or noise from the blowers; all these are objectionable. Full speed will probably not be used until the retreat, and then it is not very important, except personally to the people on the boat. This at least was the consensus of opinion among the commanding officers of our boats during the late war.

I think the Morris and Cushing may be taken as the type of the best class of torpedo boat, although the former, I am told, rolls excessively. They have sufficient speed, and are seagoing boats for use from a local base. Smaller boats such as the Talbot have not sufficiently great seagoing qualities, and only single engines and boilers, so that they are of little utility; still, in quiet summer nights they might do service. I cannot doubt for an instant that the field for torpedo boats in the way of local defense is a most important one. It is unfortunate that the lack of positive results this summer has led the general public to believe that they have been overrated, but I feel sure that this is not the idea of the navy. On the contrary, it is scarcely an exaggeration to say that the Spanish destroyers were as much dreaded as the big ships. Only the singular apathy of the Spaniards prevented them from making good use of their fine boats. In fact, the torpedo boat stands just where it did before the war began. It is a weapon with great possibilities, but its capabilites are not yet definitely known. Therefore, its moral powers will be very great until we have a fuller record in regard to it, and for this reason it must not be neglected at present. On the contrary, the element of doubt about it adds very much to its effectiveness, if it is known that the enemy intends to use it boldly.

The torpedo boat destroyer is the tactical reply to the torpedo boat. She is exactly the same type, but larger, faster, and with a good battery of light guns in addition to her torpedoes. She must be able to accompany the fleet and remain at sea with it when it blockades, in order to keep off the hostile torpedo boats. Invisibility is no longer a desideratum and she must be sufficiently high forward to be a good sea boat, and to afford fairly comfortable quarters for a large crew. The engine room force should be large enough to stand in three watches, and the fire-room force should be in three, with an extra watch to take day's duty in overhauling boilers not in use, running distillers, and for other extra work. The deck force necessary for manning the guns will be more than enough for the three watches at sea.

Speed should be greater than that of torpedo boats, but not excessively so, as the larger boat has an advantage in rough weather in proportion to her size. Thirty knots is ample speed for a destroyer, and personally I should prefer a somewhat less speed, say 28 knots, with somewhat heavier machinery and large boilers, and the duplication of parts, including main steam piping. The duty of such boats will be to act as despatch boats and scouts. When on blockade they will take the inner line, allowing the heavy vessels to lie well out every night. When two hostile fleets meet, it is probable that a general fleet action will be preceded by a combat of destroyers, just as on shore the cavalry forces feel each other and engage before the main bodies.

There should be no boats whose size is between that of Morris and the large destroyers. Money spent in such vessels is not well invested, no matter how fine they may be in design and workmanship. The reason is that the medium size boats such as the Foote and Porter, are not quite big enough to keep company with the fleet, while they are larger and therefore more expensive than is necessary to act from a local base. As the utility of torpedo boats is under discussion it may be interesting to point out why the late war threw so little light on the question.

The principal Spanish naval forces were concentrated at Havana, Santiago and San Juan, and included torpedo boats or destroyers at each place. Our forces naturally were concentrated in front of the Spaniards. At each place the opportunity of the Spanish boats was ideal, and their failure to accomplish anything is owing entirely to the singular lack of initiative, which was the universal Spanish characteristic both ashore and afloat.

As for our boats there was nothing for them to attack except at Santiago and Havana, at both of which places floating obstructions rendered it impossible to rush through the entrances, while their narrowness, and the presence of machine guns and

infantry, rendered it hopeless to attempt to remove the obstructions, and then proceed on. In these circumstances it seemed that torpedo boats might do useful service in blockading and despatch service, and they were so employed. That they were not well suited for such service is evident, but, nevertheless, they were of more or less use, and in default of proper work for them it was wise to make them do what they could, no matter at what cost to themselves.

DISCUSSION CONTINUED.

R. L. Newman said he had heard a very similar discussion in respect to British torpedo boat destroyers ten or twelve years ago. The first boats were not at all successful and there was much kicking, but the Admiralty apparently persisted in their efforts and had now developed a fine class of vessel. As to the strength of such boats, he recalled the statements of Mr. Yarrow, the English builder, made at the 1897 meeting of the Society, as to the voyages made by his boat from England to South America. The season was not selected, and yet the boats made good time and arrived in fine condition. Mr. Yarrow on that occasion had expressed surprise at the low price at which boats were taken by American builders, and he reasoned: "How could high class results be expected?" The speaker believed that when the difficulties in construction of such boats were properly realized by builders they would turn out some of the finest boats in the world, if they had not done so already.

Mr. Roberts wanted to know if anyone had any information about the disastrous boiler explosion on a torpedo boat in Puget Sound recently. Several men were killed and the tubes pulled out. This was only a newspaper report.

Colonel E. A. Stevens, from the chair, said in his experience lately with a hydraulic test he had seen a tube pull out of the lower drum of a boiler.

F. L. DuBosque said he was informed that the explosion on the U. S. S. Davis was caused by low water.

John Platt said the accident was reported as having been caused by low water. The tubes blew out but particulars had not been given out. Overheating would not cause the tubes to come out of the upper drum. This was shown very clearly from the boilers of various boats at present at the Navy Yard. He named the Porter, the Dupont, the Foote, and the McKee, and said that almost all these boats were burned out in Cuban waters. There had been no disastrous results. That sort of thing was not unusual through carelessness, and in fast running it had occurred all over the world. Never before had there been a case of any disastrous explosion because a tube had never come out of a drum after a boat had been passed and accepted.

Secretary Francis T. Bowles now read a communication on submarine boats by Lieutenant-Commander W. W. Kimball, U.S.N.

Chief Engineer John Lowe, U.S.N., in discussion, said that with the present efficient type of boat the chief question to be considered was: "Is submarine navigation useful to us?" He then referred to the use to which a submarine boat could have been put at Santiago in making a reconnoissance when Admiral Cervera's ships were in the harbor. With ordinary vessels it would have been impossible to force the entrance to the harbor without great loss of life and property, with the possibility of the moral effect that a defeat might have. He foresaw the use of submarine boats of various classes, such as observation boats, despatch boats and gunboats.

W. P. Stephens, referring to the type of vessel proposed by Mr. Dickie, said it would be a very handy little gunboat, a boat more than equal to the Gloucester and her class, and as compared with the larger of the yachts, the Mayflower, the boat would probably cost half as much and be more useful.

Stevenson Taylor, from the chair, invited experiences along the lines of the topical discussion.

Assistant Naval Constructor Richard M. Watt, U. S.N., said in the absence of officers of the Dupont and Cushing it was fair to state that those boats reached the Navy Yard with the boilers in good condition. When the torpedo fleet reached the Yard extensive repairs were necessary on most of the boats, though on several there was comparatively little to be done. These latter included the Morris, Dupont, Gwin, Talbot and Cushing. Mr. Watt said he had had charge of the repairs to the torpedo fleet, under the direction of Naval Constructor Bowles, and after many hours spent on each of the boats he was of the opinion that the Morris was the ideal type of torpedo boat proper—a boat operating from a base. "I would have no torpedo boats except those of the Morris type," he said, "and from those I would advance at one step to a 400-ton or 500-ton torpedo-boat destroyer or torpedo cruiser, or torpedo gunboat, that possesses the qualities named in Mr. Dickie's paper—seagoing and with speed and a battery superior to torpedo boats; able to serve as a scout and as a despatch boat."

Charles D. Mosher: "Referring to the remarks of Lieut. Niblack, I do not think the time for standardizing torpedo boat fittings has arrived; as ever since the beginning of the torpedo boat it has undergone continual changes, the main feature of which has been to increase the power on a given displacement, with a corresponding increase of speed. This has been realized by improved material, by advantage of the knowledge gained from past experience, by constantly greater demand for higher speed, and I believe we are to-day very far from the final speed results. Compare the speeds of some of the more recent boats, Mr. Parson's Turbinia for instance, and the contract speed of other boats he now has in hand, with the speeds that have been realized by the present boats of this Government. The speeds of these foreign boats are so much above ours that our boats would certainly be next to useless if both were to meet on equal grounds. Until the maximum speed is arrived at I think it is not practicable to attempt to standardize the fittings of torpedo boats—they have constantly been undergoing improvement. To build slower boats than our enemy has, would undoubtedly place us in a very unequal, and I may say even hazardous position, because if overmatched in numbers it is certainly desirable to be able to run as well as fight. I believe there will eventually be a very broad line between the size of the torpedo boats proper and the sea-going destroyers. Undoubtedly the harbor boats will be limited to something like 100 tons, with a speed of perhaps 35 to 40 knots; while the destroyers should undoubtedly have an equal speed with a displacement of upwards of 400 tons, and be adapted for sea going work. I believe the future destroyer will be a vessel having a raised superstructure, from which the fighting can be done, with a deck turtled over to near the water line, and equipped with conning towers, which together with the deck would be protected by 1 in. armor, so that they would be proof against the smaller guns, and in fact against any guns carried by torpedo boats. The saving of weight of the top sides of the present designs of destroyers will admit of the extra weight of the armored turtle deck, and the modified design will have greater stability due to its lower center of gravity, and at the same time present a much smaller target. From such a design a very satisfactory gun platform and a good sea boat can be developed, with very powerful fighting capacity. The conning towers, stacks and cowls would be protected by nickel steel above the superstructure, and there would be sufficient room between the superstructure and the turtle deck to admit of the free passage of any waves likely to be encountered, without destroying the upper deck. As regards the personnel, I believe no one is justified

in condemning the torpedo boat on account of the incompetency of ordinary engineers, who without training cannot be expeted to properly handle the machinery of these boats, any more than he would be justified in condemning modern high powered guns from their performance in inexperienced hands, a marked example of which was forcibly illustrated by the Spaniards at Santiago; not that they did not have good guns, but their inability or incompetency to handle them, is where the difficulty lay. I believe there are plenty of men in the Navy, who with a little training and periodical practice will be able to sucessfully handle torpedo boat machinery, and I do not believe that the torpedo boat should be condemned any more than the chronometer should, because it requires intelligent and careful treatment without this essential the modern gun or the chronometer is certainly useless. The torpedo boat is undoubtedly recognized as a very important factor in modern warfare, and if the Navy Department should insist upon it, it could undoubtedly school the personnel to give complete satisfaction."

Naval Constructor John G. Tawresey, U.S.N., prefaced his remarks by the statement that he was an avowed unbeliever in torpedoes and torpedo boats. He believed, however, that the boat described by Mr. Dickie would be a very useful type for a variety of purposes. As to torpedoes, if he were in command of a battleship he would like to have the launching tubes on deck, with a canvas cover over them, to show to folks—for the moral effect. He would like to know if that was what torpedo boats were for, or were they intended to actually destroy vessels. He did not think past experiences justified much hope for that. A vessel properly armed and on the alert would make a successful attack an improbability. Little was to be learned from the late war in which we had not fired a torpedo. The stream line motion, set up around a vessel of any reasonable speed made the best kind of a net that could be desired. If a torpedo did strike the destruction of the vessel would not necessarily follow, as experiments had shown.

John C. Kafer said it was generally agreed that the torpedo boat was built for the purpose of destroyng ships. They had maximum power with minimum weight and they could be run at maximum speed for only an hour. Mr. Dickie's boat, however, was built to keep the sea, strong enough to withstand ordinary rough usage, and yet have the machinery in good condition ready for maximum speed at all times. As to torpedoes he did not favor the automobile type. It would be much better to build the torpedo right on the end of the boat and run up to the ship to be destroyed, taking all the chances. The ordinary torpedo boat was too light to stand an ordinary sea without being shaken up considerably, and the boats now building, with flat sterns, would pound themselves to pieces in a seaway. It would not be possible to choose the time when the torpedo would go into action and so the weather might not be "such as we would like to have it." Consequently the torpedo boat should be built strongly having this in mind. Torpedo boats should not be put to uses other than those for which they were built, except in emergencies. No commanding officer should have the right to use a torpedo boat as a despatch boat. The speaker referred to the showing which the Spanish destroyers made at Santiago—thirty-knot boats running at eighteen knots.

John Platt: "I hope Mr. Kafer does not blame the Spanish boats for their speed. The protected cruisers did not do much better."

F. L. Du Bosque was of opinion that all that had been said only emphasized what Lieutenant Niblack maintained that boats should be standardized, especially where there was not available trained personnel. Torpedo boats should be so alike that a man could go from one to another and understand what the various functions of the boat were. As an illustration he referred to water-tube boilers. "Water-tube boilers are a success," he said, "phenomenally so on a great many torpedo boats, and there is no reason why they should be made a failure on any one. I believe the failure of water-tube boilers on any boat is due to neglect, when the boilers are properly designed. We have had personal experience with four different types of water-tube boilers, three of which were of excellent design. On all four, what little trouble has been experienced has been clearly traceable to managment. After some little experience I can say safely that all four of these types are now being operated successfully by the most unskilled labor in the fire room. Further than that, they are being operated from sixteen to eighteen hours every day of the week and week of the year. I do not think a torpedo boat is called upon to do such work at any time. The use of the water-tube boiler there is spasmodic and that is where the evil lies. Between the intervals of use a different force of men is employed in running the boat. If the boilers could be standardized so that the force of one boat could go to another and understand that the method of firing used on one could be applied to the other, and that the feed arrangements were identical, the boiler room force would not have the slightest difficulty in operating torpedo boats."

These expressions seemed to find much favor with the members present, for as Mr. Du Bosque sat down he was greeted with hearty applause.

Lieutenant W. P. White, U.S.N., said, with regard to Mr. Dickie's paper, that conditions on the Pacific coast were such that an ordinary torpedo boat could not live outside a harbor. He would like to know against what torpedo boats out there it was proposed to use destroyers? The only place on the coast where there would be any chance to use a destroyer would be in the vicinity of Puget Sound. The same statement would almost apply to the Atlantic coast.

Assistant Naval Constructor Richard M. Watt, U. S.N., declared that the moral effect of torpedo boats, admitted by Mr. Tawresey, justified the existence of the torpedo fleet. While Lieutenant-Commander Kimball, who was the commander of the flotilla, admitted that a single torpedo boat could not be used in daylight, yet according to published accounts of the Manila fight two Spanish improvised torpedo boats started at a distance of 4,400 yards and one reached within 1,200 yards of the flagship before she was disabled. He believed that if a small fleet of boats—only half a dozen—was to start from several different directions to attack a ship, the moral effect would be such that some of the crew of the ship would become rattled and some one boat would be able to get home a torpedo.

John Platt said that was the accepted mode of torpedo attack. Five to eight boats were supposed to operate simultaneously against a vessel. "We are apt to forget here," he said, "in discussing this matter that France has between 300 and 400 torpedo boats, Russia between 250 and 300, and Great Britain about 300 or 400. Mr. Kafer spoke of some of the boats with flat sterns. Now H.M.S. Fame of 300 tons displacement steamed from Sheerness to China unattended, and made the voyage in a perfectly satisfactory manner and arrived out in good condition."

Stevenson Taylor, in the chair, said the war with Spain did not determine the utility of torpedo boats, as they had been used only for purposes for whch they were not intended. He took exception to Mr. Kafer's statement that the boats could maintain high speed for a run of only a few minutes in view of the fact that British boats are run six hours continuously on trial. Nor was it fair to condemn the construction of torpedo boats on account of the failure of some during the Spanish war. No one could claim that the Winslow was sent to do torpedo-boat work. Boilers should not be condemned wholesale because of the failure of some. He recalled the trip of the U. S. S.

Porter around Long Island in about twelve and a half hours, "a marvelous performance for so small a boat," and yet the Porter went to Cuba and came back and had to have all her boilers replaced. He did not believe it was the fault of the boilers but rather of the personnel. "We have been having in use tools which men were not accustomed to handle," he continued. "I learned a short time ago that the boilers of the steam yacht Sovereign, now the Scorpion, had been destroyed practically, at least two or three of them had—she had four. Now you cannot convince me, knowing that the Sovereign ran a whole season and the boilers came out at the end of it absolutely perfect—there was not a leak in them anywhere—you cannot make me believe that two or three months' service on the coast of Cuba in proper hands would destroy those boilers. It is evident that we have not had the right sort of men to handle these particular tools."

Naval Constructor Francis T. Bowles, U.S.N., desired to say "one apologetic word" for the personnel. When the Ericsson in the fleet before Santiago saw Cervera's vessels coming out, she had a distance to run at full power which expended all her fresh water and she had to go on and use salt water. That was the experience of every torpedo boat. The Porter frequently exceeded the limit of her endurance for fresh water, and that had been the case with most of the vessels on the blockade. It was fair to consider that when the performance of the Sovereign on blockade was compared with her trip through the watering places.

John C. Kafer: "I had a talk with the commanding officer of the Scorpion and he said but one boiler gave out, and that was from low water. The other boilers had been performing satisfactorily during the whole trip to Cuba. He was not under the necessity of running over fifteen knots, which he could do very well, and the ship did excellent service at Manzanillo."

Stevenson Taylor, from the chair, added: "I will only say that my remarks about the Scorpion and water-tube boilers were caused by a person saying to me, when I suggested that if we built a certain vessel, of which we were then making a tender to the U. S. Government, that we would put in Yarrow boilers, and asked if that was satisfactory. I was told 'yes, but the Yarrow boilers have given us as much trouble as any other boilers—more trouble than any other boilers, and as to the Scorpion, which you built, her boilers have all given out'—words to that effect. My authority was George W. Melville, Engineer-in-Chief of the U. S. Navy. If those boilers gave out it was not the fault of the builders—that was the only point I proposed to make. I am not an advocate of water-tube boilers, have not got a patent on one, nor have I assisted in the construction of many. On the contrary, I rather advise, in the business with which I have most intimacy, against water-tube boilers. At the same time there is the other side, and it is not fair to condemn water-tube boilers on account of results which have been caused by necessity. I did not refer to chief engineers or assistant engineers, but I know it was impossible for the U. S. Government last April to get the right kind of men to take care of the water on their vessels. I know that it was impossible. They could not get the right kind of men on board of the Scorpion, because the regulations forbid it. Now what can you do? It is not the chief engineer. He cannot watch the water all the while. Nor is it the assistant engineers. But there are other important positions to be filled as well as that of the chief engineer. Therefore when I used the word personnel I had in mind the men in the fire room, the men who attend to the water and such minor duties as pertain to the under corps."

F. L. Du Bosque moved a vote of thanks to Mr. Dickie for his valuable paper.

The motion was carried unanimously.

ECONOMY TEST OF A UNIQUE FORM OF FEED PUMP.

By F. Meriam Wheeler, Esq., Member.

This paper describes a novel arrangement of marine boiler feed pump, consisting of a pair of vertical double-acting steam pumps, arranged on the cross compound plan, with steam cylinders 6 in. and 9 in. dia., and water cylinders 3 1-2 in. dia. and 8 in. common stroke. This pump was so connected on the steam end that either side could be run as a separate pump in case of mishap to the other. The valve gear of each pump was, of course, independent, so that either side could make a full stroke without interference from the other side of the pump. In the paper reference is made to the wastefulness of auxiliaries, the steam consumption of the ordinary duplex Navy feed pump being given as about 120 lbs. of steam per I.H.P. per hour. During tests of less than half an hour each the pump described worked as a compound, with 52 pounds of steam, and when running simple, with the high pressure side only, the consumption was 93.41 pounds. When run compound the initial pressure was 112.5 lbs., and when simple 67.5 lbs. During the tests the discharge pipe of the pump was throttled to put a pressure of about 200 lbs. per sq. in. on the pump cylinders.

DISCUSSION.

Passed Assistant Engineer Walter M. McFarland, U.S.N., opened the discussion by saying the question of increased economy of auxiliaries was of special importance for naval vessels in which any saving of weight was peculiarly desirable—in this case of coal carried. Wonder had often been expressed that pump makers did not adopt some plan, either cross compound or tandem compound construction, to reduce steam consumption of auxiliaries. He asked why the system described in the paper could not be employed with advantage in naval auxiliaries. Another question occurred to him in connection with the proposed new ships for the Navy (the tentative programme for the next Congress), which would probably have water-tube boilers carrying about 300 pounds pressure, with 250 pounds or 260 pounds at the engines. How would the pump makers meet the question of operating a feed pump against these high pressures? Plunger pumps had been suggested, and in a lake vessel carrying 250 pounds pressure had been adopted, in the double plunger form. That would solve the question as far as mere pressure was concerned, but he would like to know how that design would compare with the pumps now in use as regards weight and space occupied; also whether it would be possible to make a successful double-acting pump of the piston type to work against very high pressure.

F. L. Du Bosque inquired if the author had made any experiments as to the relative economy of operating pumps by low-pressure steam omitting entirely the compound system. Glancing over the figures given, the speaker was led to believe that the low-pressure cylinder contributed as much to the economy of the system as the high, consequently it might be well to operate a pump with one cylinder with the initial pressure very low.

Professor Cecil H. Peabody questioned the correctness of calling the pump "cross-compound," as his understanding of the term was that a cross-compound was an engine with cranks set at 90 degrees. He asked whether there was any fixed succession of piston strokes, and how this was maintained. "It seems to me," he continued, "there is no reason why one pump should start at one time rather than another, or in fact that one pump should keep time with another. I must make a criticism, with regard to the statement, made in connection with the test, that certain observations were made electrically and therefore were correct. I do not believe that things done automatically are therefore correct. Usually they are not, unless somebody was careful to see that

they were automatically done in a correct manner. Moreover the tests, I believe, in spite of the assertions made, are too short. Since, however, all that Mr. Wheeler wants to make out is that one pump is very much better than the other it is sufficient to prove that. Unless the pump was run for something like an hour in the condition of the test before the test was made, it is quite sure that twenty minutes would not be enough and I think even then it is doubtful. That is, however, a minor question. There are some figures in the test, too, that I entirely fail to understand. In fact it suggests to my mind the question whether the test was right. The power developed in the high-pressure cylinder is 2.54 horse power and in the low-pressure cylinder 3.07 horse power; meanwhile the speed per minute on each side was forty double strokes. The pumps were working against the same water pressure and at the same diameter. These figures do not correspond. The water end must use up a certain amount of power. It must get it from the steam end. There may be a difference of mechanical efficiency, but not to account for half a horse power, or two and a half out of three."

R. L. Newman said he had decided recently to try compound pumps and had put in one vessel compound pumps of the tandem type, the high and low pressure working directly on one plunger—outside packing. The boilers were of the Scotch type, built for 230 pounds pressure, and the pumps worked very satisfactorily. He considered it probable that there would be further economy in working pumps triple-expansion, either duplex or tandem. Another point he had considered was the centralization of the pumping system and so instead of several separate pumps for fire, bilge, feed, etc., install one or two large triple-compound pumps using say one instead of half a dozen small pumps. Again it was a question whether or not it would be well to go back to former practice and drive some of the pumps from the main engine—revolutions permitting—and have then one or two duplex pumps in reserve.

Passed Assistant Engineer W. M. McFarland, U.S.N., said as to driving the pumps from the main engine Mr. Newman undoubtedly spoke from the merchant marine point of view, while his own training had been from a Navy standpoint. "I simply want to say," he proceeded, "as showing what a radical difference there is in the practice in the two cases, that during the late war when we had a lot of merchantman brought into the Navy and armed for auxiliary purposes, we found that the machinery as put in there was by no means adapted to good use under the conditions that obtained in naval vessels. Ordinarily with a merchant steamer she starts out after things are turned over and runs, even on coasters, for quite a long trip, where all the conditions are perfectly uniform. In a naval vessel she is constantly stopping and starting, and running along at all sorts of speeds, and then lying ready to move, but not moving for several hours at a time. Yet we found complaints constantly from the engineers of those merchant vessels that they wanted auxiliary pumps put in for condensers and various other things of that kind. Then again, of course, Mr. Newman himself made the reservation, that to drive these pumps from the main engine the speed should be sufficiently low to make it desirable. I think so far as the naval practice is concerned that the method we have now gives much greater satisfaction indeed. My earlier experience in the Navy was at a time when all the pumps were driven by the main engine, except tank pumps for feeding the boiler, when the main engines were not in operation; and the ease and comfort of running a big engine on a modern ship where the main engine has nothing to do but turn the propeller as compared with the old one, is remarkable. I thought it was a good time to call attention to the difference between the requirements of the merchant service and of the Navy."

F. W. Wheeler, in replying to the various criticisms, said the tendency was towards stripping the main engines of all pumps, and as far as feed and air pumps were concerned he believed that practice was traveling forward by having them independent. He referred to "the latest Sandy Hook boats" and the "Kaiser Friederich" as examples of vessels in which direct-driven air pumps had given serious trouble. As to tandem-compound pumps, they gave better economy than the two-cylinder pattern, because they were more compact and had less radiating surface. Triple-compound pumps had been used in land practice and found to be economical-working on 27 pounds weight of steam. Centralizing the pumps of a vessel was a move in the right direction, and the pump described was a move in that direction, for instead of having a pair of duplex pumps—or rather a duplex pump—this pump could be cut in half, so that either side could be run, and by speeding up could do the work of the entire machine. As to the regulation of the strokes, the expectation when the pump was designed was that one side would go faster than the other, but on trial both sides ran exactly the same number of strokes. If, however, the stuffing box on one side was tightened up—more friction put on—that side would slow up a little. Professor Peabody had spoken about the difference in horse power. The slippage in one pump was more than in the other. It was also possible that the diagrams were not taken simultaneously. He had every reason to believe in the accuracy of the tests, for the shop where they were tested was noted for careful work. As to the economy of running a pump low pressure, tests had shown that up to a certain limit the higher the pressure the greater economy, which could be explained by the low piston speed and the difference in cylinder condensation between the direct-acting pump and the steam engine. Pumps of the type described had been built for pressures from 275 to 300 pounds.

Third Technical Session.

Stevenson Taylor was in the chair when the meeting was again called to order on Friday, November 11, at 10:40 o'clock in the morning. He announced that the first paper on the day's programme was:

THE STEAM YACHT AS A NAVAL AUXILIARY.

By W. P. Stephens, Esq., Associate.

Commencing with a reference to the practical demonstrations given during the war with Spain, as bearing on the design and construction of naval vessels, the author points to the absence of other than fighting ships in the naval shipbuilding programmes of recent years. He refers then to the rush for auxiliary naval vessels which the Spanish war occasioned. Among such vessels needed was a type, which, divided into three classes, gives: (1) Vessels for sea service as tenders to the blockading fleet or for operations in shoal water; (2) vessels for picket duty; (3) vessels for harbor patrol duty. For such work the "Naval Auxiliary Board" selected ocean-going tugs and steam yachts—of the latter twenty-seven. In the case of the yachts, many alterations in structure and equipment were needful before the vessels were ready for service. Referring to the suggestion that the government should arrange with yacht owners so that yachts would conform in construction and equipment with certain naval requirements, the author dismisses this as impracticable owing chiefly to the improbability of blending the requirements of a warship with the luxurious tastes of a yacht owner in one vessel. References to existing gunboats as too large for the services described, and torpedo boats and destroyers as too fragile and generally unsuitable are made, and a proposition follows for the construction of a special type of vessel. Of this type a vessel not to exceed 800 tons displace-

ment is suggested for sea work as dispatch boat, tender or for picket duty. In single-screw vessels the draught would be 11 ft., and in twin-screw 9 ft. For sea service on picket duty exclusively, a boat of the type would be of 400 tons displacement and 7 ft. to 8 ft. draught. Both of these classes would have a rate of speed not to exceed 18 knots at sea. The third class, for harbor-patrol service, to be composed of vessels of about 200 tons displacement and 6 ft. draught, designed for smooth waters and with a speed of 15 knots. The armament proposed for these classes would be selected from 4-in., 5-in., and 6-pounder rapid-fire guns. Such vessels would cost comparatively little and be always available for immediate service.

DISCUSSION.

Captain Jacob W. Miller, in opening the discussion, said if the money recently paid for auxiliary naval fighting vessels had been expended during the past three years in building suitable ships, better and more suitable vessels would have been available for the patrol, harbor defense, and second line work. The vessels secured were the pick of the steam yachts of the country, a point which should not be lost sight of in discussion. "As to the speed of these yachts," he continued, "the better class were down in the books as about 16 or 17 knots. There was not one yacht in this district, and I dare say it is true in the South and other districts, that could maintain a 24 hour speed of more than ten knots. You could get spurts. These yachts were built for a crew that would work half a day. The owners would go out for a short trip and they would get large speed, but it was impossible to keep it up. There was no berthing room to keep men in good condition, on the yachts, for steady work during the week. Yachts also were not suited, he said, for the rough work of harbor patrol, such as towing vessels out of mine fields, etc. He believed two classes of vessels only were needed for the work under discussion. It was not possible to divide the work of the bay and harbor from the immediate off shore work on the coasts.

Naval Constructor John G. Tawresey, U.S.N., who had served continuously as a member of the Auxiliary Board, said: "At the outbreak of the war the necessity was felt for a large number of small vessels, and the first demand that we received in that particular was for vessels for use as 'eyes to the fleet,' as it was expressed at that time, and under the direction of the Navy Department the Board proceeded to examine and purchase a large number of vessels. To avoid any misunderstanding, I would state that, as far as my memory now serves us, there was not a single one of those vessels bought because the Board considered her of a type suitable for an auxiliary—for work as an armed vessel. We did not approve those types as ones to be built, but we had to examine the vessels right at hand immediately available, and of those we picked what seemed to us the more suited for our purposes. As fighting vessels, every one of them was a make-shift. They were filled with features that were objectionable. There was not sufficient water tight subdivision, and there was not ample protection to buoyancy or stability in any other form. The coal bunker capacity was limited. There were great quantities of woodwork in the neighborhood of the positions where the guns had to be mounted, and, worst of all, the vessel as a whole was a veritable tinder box. I was amazed in walking through the Navy Yard in Brooklyn to see the great pile of woodwork removed from those vessels, and then when you went on board the vessel you would hardly miss it. The Board made the best selection it could from the vessels immediately at hand. They were selected according to the demands of the Department from time to time, vessels for this purpose and the other purpose; but the exigencies of the service caused many vessels bought for one use to be assigned for other duties. Some were sent to Cuban waters to take part in blockades, and consequently in some cases better vessels could have been selected, even from the yachts in the harbor, for certain duty than the vessels actually assigned to that duty. In most cases we were limited in the amount of money, and we selected smaller and cheaper vessels for harbor use than we would have selected if we had known they would ultimately be assigned for duty on the Cuban coast. But notwithstanding all these drawbacks these vessels did perform excellent service and they have shown an efficiency that I do not think any of us could have expected. I would like to emphasize the point brought out in the paper, that while we all admire the Gloucester and the other vessels, and the acts that they have done, we did not improvise and cannot improvise a navy from yachts and tugboats. They served a purpose from lack of other vessels, but there are types, as suggested in this paper, that would be much more suitable. This was a most wonderful war, and one of the most wonderful things about it was how few of our vessels were struck. No one can doubt that if our yachts had been struck by shells they would have been set on fire and capsized, sunk and destroyed quite as quickly as the Spanish destroyers off the harbor of Santiago. There is a field of usefulness for a type of vessel as proposed in this paper. I think we are very fortunate in having our attention called to it. In that connection I would like to go back to the paper that was read yesterday by Mr. Dickie, and suggest that the type of vessel proposed there would fill this field very well, indeed; that if we had a number of those vessels they would have features that in almost every instance would be superior to the qualities and features possessed by the yachts; especially as regards speed, coal endurance, durability and accommodation for the crews and various features enumerated in this paper. There is another matter in the paper as regards the speeds of the yachts, to which I will refer. I think that the majority of the yacht captains deceived themselves as regards the speeds of their boats and that the majority of the owners did not know what the speeds of their boats were. They represented certain speeds, But I will say that the Auxiliary Board discounted these speeds in purchasing the vessels, and that with few exceptions we were not disappointed in the speeds actually attained. We never purchased a boat nominally 18 knots, expecting that she would make 18 knots. I cannot close my remarks without a word in praise of the efficient and rapid manner in which these boats were fitted out in the Navy Yard here and other places. In a war when the events move as rapidly as they did in the late war, a little of that tired feeling that comes from continuous work day and night, a little less promptitude in adopting plans and ordering materials would have led to delay that would have been serious for the Government, that would have made the blockade of the Cuban coast weak and inefficient for a long time, and would have deprived many officers of the opportunity of performing the exploits that we have so much admired."

John Platt said: "I think we are much to be congratulated that the question of the particular kind of boat suggested by Mr. Dickie has been brought before the Society. I would like once more to emphasize the fact that the fast gunboat has not been built at all here and that nothing particularly has been done with it. All the other navies are building them and are building very efficient boats. The boat suggested by Mr. Stephens is one of probably about 850 tons displacement, and he only asks for 18 knots. Well, that is not desirable, as there is no difficulty at all in making a perfectly staunch and strong boat to make 22 and 23 knots. The boat suggested by Mr. Dickie yesterday which he calls a torpedo-boat destroyer is, of course, of a lighter class, and there he was asking 25 knots. On the horse power that he gave he would get more than that, but

he was wise to allow for considerably more horse power than would be needed, so that he could get his 25 knots easily, which is not at all an undesirable thing to do. The British Government built a large number of torpedo boats, as they call them, of this class, which average in speed from 18 to 22 knots, and we could very well start in and build a few of these boats to make 22 knots and keep that up continuously. Say the contract called for 22 knots continuously for six hours and have them designed for this, and they would be very efficient boats. Such boats, I think would be capable of performing the work suggested by Captain Miller, and after that work was done they could be used, if it was thought desirable (they being provided with torpedo tubes) as deep-sea torpedo boats or torpedo gunboats, and for convoying or operating with a fleet of torpedo boats from some base."

Naval Constructor Francis T. Bowles, U.S.N., did not approve of Mr. Platt's proposal for a 22-knot boat. He desired to see something "useful and practical"—a small gunboat that could be guaranteed to make sixteen knots between New York and Norfolk five or six times in succession. Part of Captain Miller's experience with yachts was due to the fact that he had received the small end of the fleet, which was not built for speed; and so many Naval Militia men wanted to go to sea that the captain had to put a 48-hour crew on a 12-hour boat—he was not satisfied with 24 hours. The yacht Eagle was named by Mr. Bowles as a specially successful vessel, which in a trip along the south coast of Cuba generally distanced the Marblehead by about two knots an hour, though the nominal speed of the latter was greater by several knots. He advocated only one size and class of vessel for the work.

Lieutenant W. P. White, U.S.N., fell in with the proposition of Mr. Bowles that a 16 or 17-knot vessel was what was needed, but he believed that inshore work would in time of war be always carried out by emergency vessels—the sea-going tug was adequate. For scouting work fast freight ships, with great coal capacity, would be best. He compared the steamer Yosemite with the cruiser Minneapolis, for such purposes, to the disadvantage of the latter. The "eyes of the fleet" were not intended for fighting. The lack of trained personnel was serious. The Minneapolis had very few trained men for her crew. When she first went to sea during the war there was one machinist in the engine room who had been to sea once before, and some of her machinists had never been to sea. As a question of policy he advocated the development of the fighting fleets, which were the main reliance. Auxiliaries could be improvised, but battleships had to be specially built, and as only a limited amount of money was available it would be better spent on the first line of defence.

Irving Cox dwelt upon the inefficiency of crews of the auxiliary vessels. When a yacht was being built the owner had to be considered primarily and not some future use, but yet the designer sought to make a useful sea boat, which in proper hands would cruise thousands of miles without trouble, as the speaker had experienced. One such vessel had numerous breakdowns after she was converted into a war vessel, and upon investigation he learned that the man in charge of the engine room had no experience with marine machinery, but was simply a machinist when ashore.

Colonel Edwin A. Stevens spoke of the excessive claims for speed made for yachts. He quoted a friend, who had said in reply to an inquiry about his yacht: "She is doing very well, indeed. I have beaten all the 18 and 20-knot boats around New York. The 14 and 15-knot ones bother me a great deal."

Lieutenant W. P. White, U.S.N., was again given the floor to tell what might be done in time of peace, getting ready the auxiliary fleet for war, in the way of inspection, special structural modifications, etc. He referred to the Russian auxiliary fleet running out of Odessa, which consisted of freight and passenger vessels of 7,000 to 8,000 tons. At either end of their route arms and magazines were always kept stored ready for immediate use. The magazines were great iron tanks, which could be readily hoisted in.

R. L. Newman believed that, though auxiliary vessels were very necessary, the country should first endeavor to build a navy—battleships, cruisers and vessels of that type—second to none in the world. With the increase of the Navy there would be an increase in the merchant marine, and so there would always be boats available for coast defense or harbor work in war time. The torpedo gunboat could come later. The sea-going tug was a highly efficient vessel, and likely to be an important factor in future wars.

W. P. Stephens, in closing, said he appreciated that the yachts and tugs were not selected as efficient warships, but because they were the best available. "In regard to the classes," he went on, "I have simply taken the yachts and the services to which they were assigned. Mr. Dickie's boat seems to fill the first class thoroughly. Leaving out the torpedo tubes and cutting down the speed a little it would be almost what I have suggested. That class is now represented by the Gloucester and Scorpion. We have heard the Eagle highly commended. She represents another class—about half the displacement and less draught. Such a boat would be useful for the coast patrol, for shoal work in Cuban waters, but bigger than is necessary for harbor work. The harbor work is the least important, and tugs might be converted for that purpose, but it can be done much better by a boat properly designed; a reliable boat, not of high speed, with not much coal capacity, seaworthy enough to go outside the Hook or make short passages at sea, but not to stay at sea like the coast patrol. Mr. Platt says 22 knots could be easily got. That is quite probable, but it would be better to be contented with a speed of not over 18 knots and let the other four knots go into simplicity of the engines, so that they could be handled by such crews as can be had. Trained crews are a necessity, but we are not going to get them in adequate number, so the vessels should be capable of being handled by such men as can be had. The auxiliary and the battleship have been spoken of. We all recognize the necessity of battleships and want more of them, but the auxiliaries we must have. In the case of the yachts, indeed, the money paid out would have gone a long way toward building a battleship, and there is comparatively little to show for it in the converted yacht fleet now. It would have been better if the money had been put in advance into a fleet of small gunboats. If half the cost of a battleship had been so expended we would be much better off to-day. The torpedo gunboat has been spoken of. It is a useful tool, but I believe the plain, simple gunboat of moderate speed, without torpedo tubes, and with the other requirements I have indicated, would be much more to the purpose than anything in the torpedo line at present."

DESIGNS OF THE NEW VESSELS FOR THE U. S. NAVY.

By Chief Constructor Philip Hichborn, U. S. N.

In this paper, which is of great practical value on account of the numerous scale drawings that accompany it, the Chief Constructor of the Navy has outlined the principal characteristics of the ships recently contracted for, viz.: Three battleships, four coast-defence monitors, sixteen torpedo-boat destroyers, twelve torpedo boats, and one practice sailing ship for the Naval Academy. He refers at the outset to the fine performances of the various ships of the Navy engaged in active service during the recent war, which have influenced the country, through Congress, to respond generously to naval needs. In sketching an outline of the battleships, the author

calls attention to the proposed installation of underwater torpedo tubes exclusively, and to the probable substitution of Krupp for Harveyized armor, and 12-in. guns using smokeless powder for the present type of 13 in. Speed, coal capacity, and the fact that with the advances in this direction there has been no sacrifice in the direction of draught, are in turn noted. The new vessels, indeed, will have an advantage of from 18 in. to 24 in. in draught over vessels of the same class and size in Europe. A description of the new monitors is followed by details of design of the torpedo boats and destroyers. A novel feature of the destroyers is the introduction of bilge keels, decided upon as the result of experience at sea with even the largest torpedo boats, which have been found to wear out crews in a few days, principally by excessive and lively rolling. Bidders did not look favorably upon this feature of design, because bilge keels were considered an uncertain factor in the high speed required, but the keels were retained in all contract specifications. The practice vessel for the Naval Academy—U.S.S. Chesapeake—now under construction, will be propelled by sail power, but will be fitted with an electric light plant and numerous auxiliaries, and will be equipped with a modern battery of rapid-fire guns.

In the absence of Chief Constructor Philip Hichborn, U.S.N., the paper was read by title by Secretary Bowles, who suggested that if there was to be no discussion on the paper, a very desirable discussion would be on the usefulness of monitors, "and whether they are worth while."

DISCUSSION.

Lieutenant W. P. White, U.S.N., led off by calling attention to the need of adequate coal supply in the battleship. The absence of the Massachusetts at the Santiago fight was due entirely to her lack of coal capacity, and to her having to go forty miles to coal. In battleships the space in the center just above the water line, now used for officers' quarters, might be used in time of war for bunker space. The officers could be accommodated in the after part of the ship, and the Admiral's and Captain's staterooms put up on deck—in the merchant service the captain's cabin was usually under the forward bridge. He suggested also modifications and extensions in the living spaces for the crew. Too many boats were carried on battleships, in his opinion, and he cited the Oregon, which left all but two boats at Key West during the Cuban operations. As to monitors, he had observed the Amphitrite while being towed from Hayti to Hampton Roads, and "she wabbled around like an egg shell on top of the water." They had not enough living space for crews and could not make any speed at sea. For their proper work of harbor defense, monitors were only floating forts, an expensive form of fortification, which had no purpose that could not be better served by a fort on shore.

Captain W. C. Wise, U.S.N., declared he was a "great monitor man," having had five years' experience with a monitor. "I regard to-day the Puritan as the strongest fighting ship in the Navy," he said, "and in her I think I could lick any battleship we have got, and I would not hesitate to try it."

A member, interrupting: "In a harbor?"

Captain Wise, U.S.N.: "No, sir! at sea, thank you. I had the Amphitrite. She went to sea about three years ago in a gale of wind. She was a most perfect sea boat then, and she proved her capability of riding safely out a storm in which the Maine lost men overboard, and other ships lost a lot of men overboard. Some one asked me if we could fight our guns in a gale. No admiral and no captain is going to fight his ship in a gale of wind. No battle has ever taken place in a gale of wind. I think we ought to have about twenty monitors. They are the true defenders of this country. You can take five monitors and put them off Romer Shoals, and the harbor of New York is perfectly protected, and the Navy can do it. Of course, Mr. White has reference to the Amphitrite, the Puritan and the Terror. They have got old and obsolete engines in them. But the Monterey is the right type of monitor, and I think if you give us twenty more Puritans we will take care of the defense of the country."

Professor C. H. Peabody was surprised to find, during the war, that there was a real use for the old 15-in. monitors. A warrior friend of his had told him that he would feel a great deal more comfortable if one of the old monitors was anchored in the harbor at Boston. It had given him great pleasure to know that his friend felt comfortable when the monitor came in. The speaker then expressed his disappointment that there was not a more active discussion of the Chief Constructor's paper—the most important paper in many respects. As a layman he felt it was hazardous to express an opinion, but there were members of the construction corps present competent to express opinions. He did not know whether there was a corps spirit which made it inadvisable if not improper, to discuss the subject. He noted in the design that the armor belt was carried to the bow—the full thickness carried pretty well forward, and then the belt was diminished by steps, carrying a very considerable thickness very well down toward the bow. "Now it appears that there are two methods which have been used in navies," he said, "for protecting the displacement and stability; they are by heavy armor belts near the water line, or else by an inclined armored deck behind. Sometimes they are used in combination. The English, notably, have used it of late years. It appears then that we could have either a heavy armor belt, depending entirely upon it, or else a thin armor belt, with inclined deck behind. On these ships surely for a considerable length of the ship we have both; that is, we have a heavy armor belt, with inclined deck behind. I want to ask if that is necessary. There was a remark made and insisted upon by a good number of the Society, I think both those in the service and out, and that was the undesirability of having such a variety of ships as we have in the several classes, notably in torpedo boats, where we have, perhaps, two or three of a kind at present. It seems to me that standardization, which may be very important for many things, is likely to be unfortunate in many cases. What I know about standardization is that you no sooner get a standard than you wish you had another one, and if you insist on adhering to your old standard you find you have made a mistake. But the English, in building ships in large numbers, have made some standards. They have eight or ten or a dozen, or perhaps more, in some of the smaller classes which are substantially alike. Here comes an opportunity—fourteen torpedo boats and sixteen torpedo-boat destroyers; I believe there would be four or five in each class. Now, was not this the best opportunity to insist on having fourteen of one kind and sixteen of another, and then you would have a standard for that class, at any rate."

Naval Constructor J. J. Woodward, U.S.N., explained that heavy side armor in combination with a protective deck, was used to meet the advances in explosives. With high explosives such as melinite the local destructive effects were very great, and a projectile striking thin armor would be likely to project fragments of the armor into the interior of the vessel, where the protective deck would receive and deflect such fragments and so prevent serious structural injury. His reason for thinking that this was the "proper justification" for such an arrangement of armor was that the foreign admiralties had for several years been providing their ships, throughout their vitals, with what amounted to two protective decks. The earlier ships, where higher explosives were not a factor in design, were a box

with a top and sides, but without any bottom, now an armored box with tops and sides and bottom was used.

William A. Dobson spoke about the structural strength of torpedo-boat destroyers. Mr. Dickie in his paper had recommended that some of the power should be sacrified in order that the weight might be placed at the disposal of the naval architect. In the new U.S. Navy destroyers this had been well considered along with the question of speed. Mr. Dickie had instanced the case of a British destroyer which had come into the Union Iron Works in a very deplorable condition. She was going north, and her stringer plates were entirely sheared through on one side and the butts of the sheer strake were started. In order to obviate this the Department had worked in a stringer plate of nickel steel, and made the sheer strake also of nickel steel, and the intercostal plate on the longitudinal bulkhead of nickel steel; the whole connected by bracket plates and secured to the frames, forming a large channel section, which gave ample strength in the top member of the equivalent girder.

Colonel Edwin A. Stevens suggested the inquiry, whether the conditions prevailing at Santiago were sufficiently long to give a hint as to the probable number of hits to be expected in future engagements? The Spanish ships had not been hit to any extent with large shot. If the conditions there were the probable ones, was it necessary to give so much of the capital placed in the hands of the designer to very heavy armor, necessary to keep out 12 in. and 13 in. shot?

Lieutenant W. P. White, U.S.N., said: "It would seem that the conditions of firing with great guns at Santiago were not normal conditions. Why they were not so I am not able to say. It may have been to some extent due to the smoke, which did not prevail with other ships of war; or the rapidly changing range. Whatever it was, I don't know. But the 13-in. gun ought to hit as often and, in proportion to the fire, oftener than the 6-pounder. It has a very much better trajectory, and it was a great surprise to the officers of the Service that more was not heard of the larger gun. Thirty per cent of the shots fired under those conditions ought to take effect somewhere on those ships. About three per cent. took effect."

Fourth Technical Session.

President Clement A. Griscom was again in the chair when the final session was opened at 2:15 o'clock on Friday afternoon. The proceedings commenced with the reading of the paper entitled:

METHODS OF SECURING WATERTIGHT WORK.

By Asst. Naval Constructor H. G. Smith, U. S. N., Associate.

This paper describes the methods employed in making practical tests for water tightness in naval vessels, and also the materials used for stopwaters and the way in which they are used. It gives also the results of tests of the efficiency of such materials, and concludes with the actual results of hydrostatic tests of compartments on the United States ships Brooklyn, Iowa, and Alabama. Leaks that develop under test the author classes under two heads: (1) Initial leaks; (2) induced leaks. Initial leaks are found with any head of water and are due to imperfect workmanship. They always occur, can usually be stopped and then give no further trouble. Induced leaks occur only with a considerable head of water, caused by deflection of the material, with consequent breaking of the calking and opening of water-tight joints. These depend upon the stiffness of the material, and while they may not appear with one head of water they may quickly appear as the pressure is increased. They indicate defective design. For joints not accessible for calking, after the material is fitted and riveted, the following materials for stopwaters have been tried: Tarred hemp felt, plain or soaked in red or white lead; canvas soaked in red or white lead; sheet rubber; sheet lead; red lead putty; hempen or lamp wick gaskets, soaked in white lead; asbestos; lead wire, and in some cases, copper wire. Where joints are close fitting (1-2 in. thick or under) and can be well drawn together in riveting tarred hemp is generally used. Where parts are rigid and stand apart when riveted felt is useless, and a thick layer of plastic substance, such as red lead putty, is used. Rubber, lead, canvas, asbestos, etc., are used principally in connection with pipe work. Results of several rough tests showed that for durability, canvas soaked in red lead, and red lead putty excelled. Importance of having the inner bottom thoroughly water tight was strongly emphasized when the U.S.S. Brooklyn grounded in the Delaware River in January, 1897. She lay nine days with outer bottom torn open for 126 ft. of her length, and the inner bottom subjected to a pressure head of about 22 ft. of water. No damage nor leakage was observed. Maximum deflection of inner bottom was at first 3-4 in. and gradually increased to 7-8 in. Bottom plating was not shored down. For a protective deck of three thicknesses "which always gives trouble," the author recommends forcing red lead putty between the layers throughout the whole length, or calking completely underneath as well as on top. In conclusion, he makes these recommendations: (1) Fitting rigid bracketing to all stiffeners on bulkheads below the water line; (2) Fitting of double bounding and staple angles to such parts of all bulkheads as may be below the water line; (3) Fitting of a vertical stiffening bar or double staples on all watertight floor plates of a certain size, except where the plate is in direct line and adjacent to a bulkhead above; (4) Fitting of the protective deck in two thicknesses instead of three; (5) Fitting of all plating behind armor in one thickness instead of two; (6) The use of double riveted lapped butts and seams, instead of strapped butts and seams, in case of the inner bottom, platform and splinter decks and all bulkheads; (7) As an alternative to (6) the fitting of a stiffening far along the seams in the case of all light flush plating fitted with straps. These would entail an increase of weight, which could be taken care of by a readjustment of scantling weights, or by increased displacement.

TEST OF THE STRENGTH OF A LONGITUDINAL BULKHEAD SEPARATING TWO ENGINE ROOMS.

By Naval Constructor J. J. Woodward, U. S. N., Member.

This was carried out on the battleship Illinois under construction at the Newport News yard in accordance with a clause in the specifications for the construction of the battleships Kearsage, Kentucky and Illinois. This required that all water-tight compartments should be tested by filling the compartments with water under a head. The most important bulkheads were the center line longitudinal bulkheads between the engine rooms and fire rooms of the vessels. The head of water to be used for the test was 5 ft. above the normal load line, corresponding to a water level of 28 ft. 6 in. above the keel. As the workmanship in all three vessels was entirely satisfactory it was decided to apply the test in one ship only to determine whether or not the scantlings as designed were sufficiently strong. The engine room bulkhead of the Illinois was selected, and as the volume of one engine room was so great that to have filled it would have strained the vessel (she was on the blocks in the building slip at the time) a wooden cofferdam of 5 in. plank was built in the port engine room about 3 ft. 9 in. from the center line bulkhead. The hydrostatic head was obtained by using a small

stand pipe connected with the water space within the cofferdam through a hole in the protective deck. During the first tests a good deal of local distortion was observed until a head of 22 ft. 4 in. was reached, when, owing to the buckling of some brackets, the test was stopped. Additional stiffening was worked in, and a second test made with the maximum head, for a long period, after which various stiffeners were found to be strained beyond their elastic limit. Further structural alterations were then made, and a final test proved entirely saisfactory, and accordingly the similar bulkheads on the other ships were reinforced in a similar manner. In his observations the author calls particular attention to the class of bulkheads under consideration. In this class satisfactory general strength to prevent collapsing is the chief requisite, as is the case with the ordinary bulkheads of a man-of-war, and in which a slight amount of leakage through rivets when under the maximum test is not a matter of any moment. For those bulkheads in which *absolute* watertightness is necessary, as in trimming tank bulkheads, etc., where, in addition to satisfactory general strength, there must be such local stiffness as will prevent any leakage whatever, under all possible pressures, the method of nalysis that the author proposes, will apply only to the consideration of general strength, and in such cases experience of past practice will be a determining factor. He also expresses the belief that for bulkheads introduced to prevent collapse and not for *absolute* watertightness, wider spacing for stiffeners than the customary 30 in. is permissible, increasing indeed to 4 ft., with accompanying increase of strength of stiffener bars. The additional use of belt stiffeners is also advocated in bulkheads in which length is relatively greater than depth, and which are subject to considerable heads of water pressure. In making his calculation the author has employed such a method as will permit of the determination of scantlings in other generally similar conditions.

The two preceding papers were read in succession, so that the following discussion could be along the lines of both, the subjects being so closely related.

DISCUSSION ON TWO PRECEDING PAPERS.

Naval Constructor John G. Tawresey, U.S.N., in opening the discussion referred to Mr. Smith's paper and said he could not refrain from expressing his surprise, and even sorrow, that a member of the Society and a naval officer should propose to divide water-tight bulkheads into two classes—"one that must be water-tight and one that may leak." He understood that in testing for water-tight work small leaks would be found and corrected, and it was not always necessary to repeat the test on this account. "But how are we to strike a target if we do not aim at the bull's eye?" he exclaimed. "A bulkhead, at least under the static conditions of test, such as described in these two papers, appears to me an unsafe bulkhead to take the pressure due to the skin of the ship being punctured and the stress in a seaway. If we were looking at it more in a historical point of view we could divide bulkheads into these two classes—bulkheads that are water-tight and bulkheads that leak, and I am sorry that there are many of them in the second class; but I do not think that turning to the future we should design them or test them with that in view at all. A bulkhead that can leak a little will leak a little more—probably will leak a great deal more." A reading of the paper, he went on to say, might give the impression that the Alabama was a poorly constructed ship, so far as watertightness was concerned, but exactly the contrary was the case. She was probably one of the best ships constructed. Leaks were not an affliction known exclusively in the Navy. In merchant vessels many leaks not found were not sought after. In merchant vessels it was often considered sufficient that the outside plating should be water-tight, and even this was not aways the case on launching. Navy vessels were much more difficult to make water-tight. Subdivision was carried much further than in merchant vessels, and then the system of ducts, ammunition hoists, etc., cut up the bulkheads considerably. He instanced one case in which a bulkhead had not a single stiffener left intact, and in fact the bounding angle had been chipped in places to get room. Such a condition invited disaster. Draughtsmen were, in the speaker's opinion, largely to blame. The principles of laying out water-tight work were not sufficiently understood, and many men also in responsible positions did not put into practice what they knew. Another criticism he had to make was concerning countersunk rivets. There was no excuse for not having the point of a rivet water-tight; it was usually the head which gave trouble. He had used successfully countersunk rivet heads to secure water-tightness, and had designed to have the heads calked. It was much more difficult to get at the head of a pan-head rivet to calk it than a countersunk rivet head.

Professor Cecil H. Peabody did not think the necessity and importance of such experiments were sufficiently appreciated, especially by the people, as they ought to be, for the reason that people could not see when a ship was finished that there was anything at all commensurate with the expense incurred in making a compartment strong enough to withstand pressure. It would seem that a logical thing to do would be to make a series of experiments, covering sufficient ground, so that the data upon which calculations should be based would be sufficient. Then with appropriate treatment, the information could be put in such shape that one could infer from positive knowledge in one case very closely what might be obtained in some other case.

R. L. Newman recounted a common experience on the Great Lakes, a boat sailing from Lake Superior, carrying possibly 250,000 bushels of wheat, would get aground coming through the canals and puncture several holes in the bottom. Then protection would depend entirely upon the inner skin. There were cases in which the vessel came through this ordeal and delivered cargo at Buffalo, having damaged only 25 or 30 bushels of wheat. "We rely principally upon our longitudinal keelsons and our tank tops butted with channel butts," he explained, "we avoid, as much as possible, all joints which would involve calking. Our marginal plate is, as a rule, flanged to the skin of the ship. Also we use collision bulkheads."

John C. Kafer, referring to a remark made by Mr. Tawresey with reference to two kinds of bulkheads, said: "If he would remember that a bulkhead is made for one particular object in one case, and for a different object in another case, probably he would not object to whether it leaked or not. The bulkhead in a vessel is usually made to keep out the bulk of the water; that is to keep the water from rushing in and sinking the vessel. That is the chief object of the transverse bulkhead. In a war vessel where it is necessary to have a bulkhead absolutely watertight, there it is necessary to be very careful indeed. I would not care in a ship whether a bulkhead would leak a barrel of water an hour or not, provided I could keep the mass of it out. It is the strength of the bulkhead particularly that we want to look after. It would be perfectly permissible to have two kinds of bulkheads, some that are water-tight and some that are not. There is no necessity for a builder going to the care of making a bulkhead absolutely water-tight, where one that is practically water-tight, that will not leak more than the pump will take care of, would be sufficient."

Mr. Tawresey in response said: "I am not objecting to two kinds of bulkheads. I am objecting to two kinds of 'water-tight bulkheads.' I do not object to a trifling amount of leakage; but it appears to me that we are exposing ourselves to great danger by

taking a bulkhead that leaks any appreciable amount under the static conditions of test; we expose ourselves to the danger of its collapsing altogether at sea. Of course it is usually said you can go down and shore them up."

F. L. Du Bosque said in early days of the construction of the Navy water-tight bulkheads were a source of constant trouble between builders and the Navy Department. The difficulty at first arose because the Department could not accept the standard practice for making water-tight work in the merchant service. Naval vessels, he said, were divided into a great many compartments, and they called for the extensive use of staple work. In the merchant service it was customary to make this staple work tight by means of canvas and red lead. The whole difficulty had been solved, by the admission of Mr. Spear, through his tests, that absolute water-tightness could be accomplished by red lead. As to rivets—the objection to soft rivets. It should not be forgottent that in driving a rivet sometimes the plate was cold as ice, and at other times too hot almost to touch. For this reason soft rivets were used, as the rivet cooled off very quickly and became hard, and in winter time in driving rivets they cooled so rapidly that they were set up cold. As to stiffening bulkheads he suggested that, "a good deal of lightness could be saved" if a different section of stiffeners had been used. A bulkhead could be made much stiffer and as cheaply if the Z bars were replaced with a proper section of bar, of greater width and of greater area on the outer edge. In reply to an inquiry the speaker said the well-known angle-bulb would seem to accomplish the result.

R. L. Newman by way of comment said: "I do not think that the last speaker's remarks are quite correct as to our relying in the merchant service on canvas and red lead for water-tightness. We have inspectors who follow the work very closely, and they absolutely decline to allow the use of either tar paper or red lead. I have been in the unfortunate position of endeavoring to get permission to use it. We had to obtain our tightness entirely by calking. I have seen the work turned out for the Government and also for the merchant marine, in water-tight work, and so far as we are concerned, both practices are coincident."

Colonel Edwin A. Stevens inquired what, in the Service, were the assumed conditions which a bulkhead structure was supposed to meet. The British Bulkhead Committee, as he recollected, had recommended that the stiffening should be considered as the frame work, the plating over that adding absolutely nothing to the power of resistance. He related an experience with a very shallow section of bulkhead, which seemed to be strong and well proportioned, and yet gave astonishing results. The attachments to the skin were entirely inadequate to have stood a head of water four or five feet above the water line. He asked what—under the assumption of a five foot head, such as was used for a longitudinal compartment—was the factor of safety?

Naval Constructor Francis T. Bowles, U.S.N., referring to a criticism made, said that draughtsmen were not so much to blame for the difficulties in securing water-tightness as engineers and electricians who came along and drilled a bulkhead full of holes after it had been made thoroughly stiff and tight.

Naval Constructor J. J. Woodward, U.S.N., discussed at considerable length several propositions in Mr. Smith's paper relating to the construction of protective decks.

Assistant Naval Constructor H. G. Smith, U.S.N., in closing the discussion, said that on the Brooklyn an average of five men were constantly employed for more than fourteen months in securing water-tightness throughout the ship, and in later ships, the Iowa and Alabama, where a great many more compartments were tested, the amount of work was increased. As to countersunk rivets he had found that this shape of head was more liable to leak than the pan head; and the countersunk head when driven nearly always projected from the hole, and it was necessary to chip off the head before it was calked. Pan heads could be calked by special tools adjacent to the heel of the bar. He recommended doing away with the countersunk head, not so much to replace it with the pan head, but because a thin layer of tar hemp-felt could be applied where it was used. As to finding the amount of stiffening necessary on a bulkhead, this would have to be ascertained in each case largely by experiments.

AN ELECTRICALLY OPERATED 150-TON REVOLVING DERRICK.

By Walter A. Post, Esq., Associate.

This paper contains a complete description of one of the largest jib-cranes in the world. It was recently constructed and put in operation at the Newport News ship yard, for handling heavy armor plates, marine boilers and other great weights in fitting out and repairing ships. A 100-ton sheer legs alone had previously been used for such work. The new crane was designed to conform to these requirements: Capacity to lift the heaviest single weight; a large field of operation and absolute precision within this field; a location accessible from any part of the yard; and economy in respect of cost of construction and operation. The derrick is located on a pier 700 ft. long with deep water and ample mooring space alongside. Piles form the foundation, which is filled in to afford protection from the teredo. The jib can be raised and lowered and the derrick revolved so that the hoisting block will describe circles of 88 ft. and 207 ft. as the respective circuits of operation. The maximum load of 150 tons can be handled within a ring having maximum and minimum diameters of 147 ft. and 88 ft. respectively, and loads of 70 tons can be handled at any angle of jib. The maximum elevations, above mean high water, for the hoisting hooks in the high and low positions of the jib are 118 ft. and 69 ft. respectively. The derrick proper revolves on conical steel rollers on a track 36 ft. in diameter, which is carried on top of a circular steel tower secured to the pile foundations. The derrick is operated by electricity, various motors for revolving the movable structure, raising or lowering the jib, and for hoisting, are conveniently located in the housing, which also carries the counter weight or ballast. Various results of tests are included in the paper, the maximum in the several operations showing: Hoisting, net load, 152,320 pounds; speed, 6.05 ft. per minute; moving jib from lowest to highest position, 6.9 minutes; complete revolution with load of 300,160 pounds, 3.38 minutes.

This paper was read by title, as the author was not present, and no discussion followed.

STABILITY OF A BATTLESHIP UNDER DAMAGED CONDITIONS.

By Prof. C. H. Peabody, Member.

This paper is an account of the results of model experiments with a battleship of these general dimensions: Length between perpendiculars, 368 ft.; beam, 72 ft.; normal draught, 23 1-2 ft.; height of main deck above normal water line, 11 ft. The investigations were intended to show the effect of such injuries as would admit water to compartments on the protective deck outside of the armored transverse bulkheads, and also of flooding certain of the compartments below the armored and protective decks. The model was of wood on a scale of 1-4 in. to the foot. It was made in two parts representing the lower and upper body of the ship; and with the inclining apparatus in place it was ballasted so that it floated at

the proper water line, and so that it had the proper metacentric height. Blocks representing the parts which were supposed to be laid open to the sea were cut out, and lead weights fastened to compensate for the wood removed. The initial inclination for a given condition was then determined and also the change of trim, as well as the new water line. Inclining experiments were then made to determine the initial stability at various angles of heel. To properly understand the results the use of diagrams is of course necessary and these accompany the paper. In general it was found that extreme conditions were shown to develop dangerous effects. The fact that so extensive injuries are unlikely, says the author, show that the designer provided agrainst all probable conditions, except the effects of large submarine mines.

DISCUSSION.

Naval Constructor J. J. Woodward, U.S.N. in criticism said all the center superstructure in the ship was entirely neglected. In action the superstructure would not be intact, as the gun port shutters would be open, and probably there would be shot holes through the outside plating. In time of peace, however, a serious accident might occur in one engine room, and the ship go under 15 degrees. It would still be possible to close the gun ports in the superstructure, and thus render that part of the ship practically as intact as the forward and after ends above the protective deck. The addition of the superstructure would, in his opinion, make important changes in the stability curves.

John C. Kafer spoke about the effect of longitudinal bulkheads, and referred to the previous speaker's assumption that by having a longitudinal bulkhead it would be possible to operate the engine on one side after the other side was damaged. "But if the ship turned over," he said, "it wouldn't be of much use. I am dead set against longitudinal bulkheads, because if the stability is not sufficient, all your bulkheads will be of no use; but your engine will run just as well under the water as above the water for a short time. at a moderate speed. I am opposed to the longitudinal bulkhead, and I am glad that Professor Peabody has brought it out so prominently here, to show the danger of having one side of the ship filled with water with nothing on the other side. It is a great deal better to have the ship go down on an even keel, as he has shown here with his model, and I do not know of anything that is more dangerous in a ship with very little stability, as is the case with many of the merchant ships built now, than a longitudinal bulkhead."

Naval Constructor John G. Tawresey, U.S.N., said that a longitudinal bulkhead that would cause a ship to capsize was bad, but it had been the custom to investigate that question in designing ships, and he believed few vessels would be found fitted with a longitudinal bulkhead where the flooding of one or even two compartments on one side would cause the vessel to capsize. If all one side of a ship was flooded she was bound to capsize. The way in which H.M.S. Victoria foundered was pretty well understood now. The first newspaper accounts alleged that the ship had turned over because she had a middle line bulkhead, and consequently it had been very popular for a week or two to jump on the home ships. Having taken a special course in naval architecture at the British Naval College, when this matter was under consideration, the speaker had special opportunity for getting exact information. It was well known now that the ship was not lost in that way.

Professor Cecil H. Peabody responding said the suggestion of Mr. Woodward was a good one and worth carrying out, but the experiments had been made without the superstructure for the very reason stated by Mr. Woodward—ports would be left open in action. He was quite familiar with the reasons for the existence of the longitudinal bulkhead, and it was clear that if the flooding of one compartment on one side would put the ship in a dangerous position, the flooding of two compartments (athwartships) would rectify that difficulty. The question was whether the flooding would be done at the proper time? He understood from the statements made, that in the new battleship designs the filling of two compartments on one side of the longitudinal bulkhead would not cause the ship to capsize. In the case discussed in his paper—unless the model experiments were with grossly different conditions from the ship itself—it appeared as if the ship would be almost certain to capsize, if two compartments on one side were filled.

TOPICAL DISCUSSION.

President Griscom now called attention to the topical discussions on the programme, and said that on account of the amount of time which had been consumed in discussions of papers there was little time left. Under the circumstances it was thought best to limit the discussion to the first question, viz.: "Under the circumstances of the blockade at Santiago which was the more economical method of maintaining the boilers in readiness for immediate action—banking the fires or keeping them spread but very thin?"

John C. Kafer informed the members that he had invited Chief Engineer Milligan, who had been Chief of the Oregon, to attend the meeting and give his experiences. Chief Engineer Milligan was unable to accept the invitation, as he expected soon to go to sea and was then at Hampton Roads. He, however, had written a letter to Mr. Kafer which reads:

LETTER OF CHIEF ENGINEER R. W. MILLIGAN, U.S.N.

"On the Oregon we kept our fires spread and thin. I did that more for mechanical reasons than for anything else; that is, to save the boiler from cold air getting in and striking the tubes. We consumed from twenty-four to twenty-seven tons per day. It must be borne in mind that the engines were used frequently to maintain our position, there being about 200 fathoms of water, in which we could not anchor.

"The Iowa kept nearly all her fires banked and enough spread to handle engines. She always (at noon, when we all signaled to the flag-ship, the coal burnt and amount on hand) consumed from four to six tons more than we did. We had to use our bleeders frequently, and, of course, there was a waste. I would say banked fires would be more economical on coal alone, but under the circumstances I always said 'damn the economy; efficiency is what we want,' and my actions were governed accordingly.

"Difficulty in maintaining fresh water in boilers varied on different ships. You might say it was a local question. None could be had from shore or any other source except the ships themselves. It depended upon the number of leaks, what I call illegitimate losses, and the peculiar ideas some medical officers had about the purity of distilled water. All our evaporators want to be increased about 50 per cent. Those furnished to the Oregon would make the amount they were rated (5,500 gallons per day) but the water showed considerable salt under nitrate of silver test. Still we never had any trouble among the men from drinking it. Our doctor passed it, but with the remark that it was very bad water. Other doctors insisted on the water showing no salt at all, but that would decrease the output of the evaporators fully one-half, as they had to be run so much slower.

"I noticed on ships where the distillers were some height above the evaporators that better water was made, and would recommend twenty feet if possible. Only the distillers need be there; the pumps, etc., could be down alongside the evaporators so as to reduce the number of men to run the plant. The Oregon was remarkably free from leaks, but she would use about 2,000 gallons per day to make up losses in feed.

"We had no trouble with our machinery. From all I can hear of other ships, condenser tubes gave most

trouble. The remedy is to use heavier tubes, nothing lighter than No. 18, B. W. G., and No. 17 would be better. In all the new ships there is a great deal of auxiliary machinery seldom used, but in an emergency all is used. Not being used it is liable to be neglected. We had a well established routine to move all this machinery every day, and if for any reason it could not be done, the reason was entered in the steam log. If this is attended to, I see no reason why any difficulty can occur. We had hydrokineters in our tanks, and always kept feed water at the constant temperature of 140 degrees. No drains led into the feed tanks except from traps of evaporators; all other drains either led to auxiliary or main condensers. Some ships have all the drains discharge into feed tanks. This keeps them too hot and gives trouble. I forgot to mention that nearly all ships had trouble with cold salt water copper pipes, from pitting. This is easily overcome, however, by sweating soft patches on; had some on the Oregon patched nearly a year and gave no trouble. Where salt water was used in boilers their crown sheets invariably came down. Quite a number were crippled from this."

After reading the letter Mr. Kafer said, in his own experience, banked fires were more economical, but in a case of this kind economy did not figure at all. It was a question of making the vessel more or less efficient, and there was no question in his mind but that it was better to keep the fires spread, and have them ready to "go ahead" at a moment's notice.

Passed Assistant Engineer Walter M. McFarland, U.S.N., read a hasty abstract of the engineer's logs of the Santiago vessels, which he said needed revision before being made a part of the proceedings. He agreed with Mr. Kafer that there was an enormous advantage in having the fires spread; "because everything was ready then to jump at a minute's notice."

John C. Kafer added that Mr. Milligan had told him with regard to the Santiago fight, that, when the ships came out, within fifteen minutes after the signal was given, the Oregon was ready to go "full speed ahead."

RESOLUTION BY LEWIS NIXON.

Lewis Nixon now offered a resolution which had been suggested by the discussion of some of the papers. "It is but a step from the loss of a ship at sea to the loss of life at sea," he said, "and I think it is to a society such as this that the traveling public must look for suggestions and methods that aim to save life at sea, and to inspire confidence in the sea-going public. The lack of appliances for saving life, or their absence or both, have led to numerous horrors, some of the details of which are fresh in our minds from very late disasters, and it would seem that a discussion of such appliances should form a part of the proceedings of our next annual meeting, not only from the fact that they are of interest to us as naval architects, but that it is a duty that such a society as this owes to mankind. Since the earliest time, so far as I know, there have been practically no advances made in the method of saving lives at sea; certainly nothing commensurate with what has been done in other directions. Some people have told me that in a howling gale it was of no use to make an attempt to save people. However, that is cowardly and we might as well dismiss any such idea as that. In the methods of handling weights, and in being able to apply power to handling boats and other appliances looking to the safety of life at sea, the advance has been so great that it certainly seems to me that the troubles that arose in handling old fashioned sailing cutters, on our ships of war twenty years ago, were far greater than the conversion of the smoking saloon into an ark of refuge for the entire crew and passengers. However, I simply wish to offer a resolution, and I beg therefore to offer it: "That papers be invited upon the subject of life-saving at sea for the next annual meeting and that two such papers be selected by the Executive Committee for publication and discussion."

Naval Constructor J. J. Woodward, U. S. N., seconded the motion and it was unanimously carried.

CLOSE OF THE TECHNICAL SESSIONS.

Votes of thanks were then passed to the American Society of Mechanical Engineers for the use of the auditorium, to the President of the Society for his courteous conduct of the meeting, and to Secretary-Treasurer Bowles. In putting this last vote the Chairman gracefully referred to the labors of Mr. Bowles, which were distributed over an entire year in preparation for the meeting, and this vote was the occasion of a hearty demonstration of good will and appreciation.

Then the sixth annual meeting adjourned without date.

Social Features of the Meeting.

As is customary at the gatherings of the Society, the professional programme was followed by the annual dinner, held at Delmonico's on Friday evening, November 11. More than one hundred members and guests were in attendanace, and for their edification a list of toasts and speakers to respond was arranged. These were, "Our Navy, It Has Justified Its Existence and Glorified the Nation," H. D. Goulder; "Our Commercial Marine, Its Development and Extension is a National Necessity," Senator George F. Edmunds; "The Naval Militia," Captain J. W. Miller; "Naval Architecture," Lewis Nixon; "Marine Engineering," W. M. McFarland, and "Our Manufacturers," Theodore C. Search. Secretary Francis T. Bowles said the final word in response to a very hearty call from every part of the room. He predicted a great expansion for the American marine (naval and mercantile) and referred to the results which would be acomplished by the members of the Society.

While the general meeting was in progress a special invitation had been extended to the Society by the Bethlehem Iron Company to visit its plant at South Bethlehem, Pa., on Saturday, November 12. This was very generally accepted, even by many out of town members, who otherwise would have returned home promptly at the close of the meeting. Early on Saturday morning the members gathered at the Pennsylvania depot, in Jersey City, and took special cars attached to a fast train, which ran over the Lehigh Valley route. On reaching the works the cars were switched into the company's yard and here the members, who had been accompanied down by H. F. J. Porter, of the company, were transferred to an observation train. This was run over the yard tracks into the various shops of the immense works. The forge was first visited, where the powerful hydraulic presses were shown in operation working heavy engine forgings. After this an open-hearth furnace was tapped and the ladle run to the Whitworth fluid compressing plant, in which the well known system of cooling an ingot under hydraulic pressure was exhibited. Then the heavy forge and the armor plate plant were both shown in operation. In this building there stood an imposing monument to the advances in metallurgical processes and to the enterprise of the company, in the monstrous Nasmyth hammer. Dismantled, and with the anvil block removed, it was very impressive, even in a works so filled with the grandest demonstrations of modern science. Hardening of armor plate was next on the programme, and then another spectacle was witnessed in the silent withdrawal of a great gun jacket from a vertical gas furnace and its rapid disappearanace in an adjacent tank of oil with an accompanying flash of flame. There was so much to be seen that only brief stops could be made and so the members hurried through the assemblage of heavy machine tools for finishing

armor plate, and also the main machine shop. Some idea of the extent of this can be had by considering its length—a few feet under a quarter of a mile. Here there was an immense variety of steel work in the various stages of finishing, including crank and line shafts, guns ranging from 4-in. rapid firers to 12-in. breech loaders with their carriages, and a great variety of steel forgings and castings in as great a diversity of machine tools. After the various steel making departments had been viewed the members were entertained at luncheon in the company's office, and the appreciation of the Society, of the very interesting and instructive visit, was expressed by Member of the Council John C. Kafer, and responded to by R. W. Davenport on behalf of the Bethlehem Iron Company. On the return run it was generally agreed that those members who were unable to take the outing had missed one of the very pleasantest features of the Sixth Annual Meeting.

PAPER ON TOPICAL DISCUSSION.

BY WILLIAM S. ALDRICH, MEMBER.

A very interesting paper was contributed by Mr. Aldrich, who served as a volunteer naval officer during the Spanish war, on the topical question: "As a result of experience on the blockade, what particular points about the machinery were most likely to give trouble, and what could be done to prevent a recurrence of such trouble?"

"I would bespeak a brief consideration of this question from a slightly different standpoint. The work done by the United States repair ship Vulcan, for fifty-four vessels of the regular and auxiliary navy, including all of those of Admiral Sampson's fleet, will of itself form a partial, even if an indirect answer to the question: 'What particular points about the machinery were likely to give trouble?' The Vulcan's part in the war was entirely constructive. Its mission was to make good by thorough repairs or by entirely new parts, those portions of the machinery that actually gave way or were so worn out as to require immediate attention. In addition to this large quantities of engineers' and equipment stores were issued on requisition to the different ships.

"While fitting out at the Boston Navy Yard, the writer was attached to the Vulcan and was later brought into daily contact with the execution of the repair work on the 'shop' deck, during July, August and September, as she lay at anchor in Guantanamo Bay. A detailed account was kept daily of all repair work done, whether executed on board the Vulcan or by her force on board the respective ships, making requisition for such outside work.

"It would extend far beyond the prescribed limits to give even a table of contents of the work done for the steam engineering department of the several vessels, not to speak of that done for the equipment, navigation, ordnance and construction departments of the same. No sooner had the Vulcan come to anchor than she was pressed into requisition for all kinds of repair work. It seemed as though about everything on each and every ship was on the point of giving way or needed repairs. As time wore on such work very naturally arranged itself into characteristic groups. A brief enumeration of these may serve to show 'What particular points about the machinery were likely to give trouble,' whether on blockade duty or occurring in distant waters without access to a navy yard.

"About the main engine, bent piston rods and valve stems, broken packing rings and eccentric rocker arms called for repairs, along with general overhauling, taking leads of cranks and wrist-pins and lining up engine girders.

"Reversing or jacking engines had broken worms, bent shafts, loose and worn collars, keys out of shape and required general tightening up all around.

"Capstan engines presented broken cast iron crossheads, worn wrist-pins and very many broken eccentric straps, and badly worn boxes requiring new ones or re-babbitting old ones.

"Winch engines required the same line of repairs as capstan engines, especially in worn boxes and broken eccentric straps.

"Crane engines required new boxes, new worm wheels, new shafts, new keys and much general overhauling. The cast worm wheels were particularly weak and where not broken in two parts, came up for repairs with several teeth missing.

"Blower engines had broken cylinder heads and required new pistons and packing rings and overhauling of slipper slide.

"Steering engines required chiefly a general overhauling.

"Dynamo engines presented broken mild cast-steel crossheads, broken eccentric straps and rods, where cast in one piece, bent and broken valve stems, broken cylinder heads, worn piston valves and loose wrist pins. One governor wheel required to be rebushed.

"Dynamos were tested for grounds and broken circuits in fields and armatures, and one commutator was trued up.

"Electric motors attached to the small blowers were overhauled and the armatures of two of them rewound.

"Ice machines required new valve stems, slide valve and crosshead.

"Steam pumps called for most numerous repairs to the valve motion, many of the duplex type required rebushing throughout. Broken slide valves and supplementary valves were replaced by new ones. The water ends evidently gave the most trouble and required most general overhauling, chiefly in the soft packing and water pistons. The small duplex pumps of steam launches were continually getting out of order. A common fault with steam launches was the fine waste in the feed checks.

"Steam boilers required scaling, new baffle plates, new grate bars, new internal feed systems, new tubes and expanding and rolling old ones; replacing of badly corroded connections on account of not using zincs properly, repairs to blow valves on account of deranged or broken parts, new tube stoppers, manhole dogs and bolts; calking, particularly of bottom seams; and jacking up of furnaces, down in the corrugation or flat (cylindrical) surface or both in the same furnace. Launch boiler required new dome and ash pan.

"Many cases of badly corroded copper-pipe came up for repairs. In other cases leaks had developed around the soldered and brazed joints and connections where the same had been subjected to mechanical strains which, of course, is an ever recurring trouble in marine work. Very few leaks had occurred in the body of copper pipes due to bad brazing originally or internal pitting or to thin metal. In the case of unbrazed flanged connections the joint was made tight again by refitting the end of the pipe and planing anew into recess in flange.

"Globe and gate valves and plug cocks required reseating, new valves, new top and stems, new plugs. In many cases old valves were entirely replaced by new valves taken from engineers' stores or made from patterns and castings finished in the machine shop. Air pump valve seats, studs and nuts were in demand.

"Steam and water piping required many changes on some of the regular, as well as several of the auxiliary vessels to more thoroughly adapt it to the needs of such distributing systems. Steam gauges were standardized. Electrical fittings were altered for more convenient distribution. Many manufacturing orders were executed for spare parts, such as air pump valve seats, ash hoists, castings, plug cocks, wrist pins of small engines, special studs and screws, special spanner and socket wrenches, reducing hose couplings, crank and ring flanges to check valves, valve stems and bushings.

"The above does not include any of the work done on the former Spanish vessels, the Sandoval and Infanta Maria Teresa. Members will no doubt be surprised to find that many unexpected points of weakness developed in the small and numerous elements of the auxiliary machinery of naval vessels and that much that was expected to give trouble gave no trouble at all. As in other branches of steam engineering, the larger the unit the less liability to derangement."

Changes in Plans for U. S. Monitors.

In our issue of October we published a description, with drawings, of the harbor defense monitors Arkansas, Connecticut, Florida and Wyoming, as originally laid out by the Navy Department. For the vessels so described the bids which were received included the following:

Newport News, S. & D. D. Co.....	$860,000
Bath Iron Works, Bath, Me.....	862,000
Lewis Nixon, Elizabethport, N. J...	825,000
Union Iron Works, San Francisco, Cal.....	875,000
Maryland Steel Co., Sparrow's Point, Md.....	876,000
Wolff & Zwicker, Portland, Ore....	937,500
W. & A. Fletcher Co., Hoboken, N. J.....	927,000
Columbian Iron Works, Baltimore, Md.....	1,015,000
John H. Dialogue & Sons, Camden, N. J.....	1,171,000

The successful bidders and boats which were assigned to them were the following:

Newport News S. & D. D. Co.	...Arkansas
Lewis Nixon, Crescent Shipyard.	.Florida
Bath Iron Works	.....Connecticut
Union Iron Works	.....Wyoming

Before any work was commenced, however, the Navy Department decided to make radical changes in the plans of the vessels, so that instead of having one turret each they would have two and the dimensions would be increased considerably all around, giving vessels with:

L. W. L. length	.....260 ft.
Beam extreme	.....57 ft.
Mean draught at normal displacement, about	.....14.5 ft.
Normal displacement, about	.....4,000 tons
Total coal capacity	..... 400 tons

The changes would include substitution of two turrets for one, as noted, with an increase in armament giving four 10-in. breech-loading rifles, four 4-in. rapid-fire rifles and seven smaller guns in the secondary battery. The revised plans also provide, of course, for larger storage spaces, and for power sufficient to maintain a sea speed of 12 knots on two hours' trial. The increased machinery dimensions include twin-screw engines of 3,200 indicated horse power, with cylinders 18 in., 33 in. and 46 in. dia., by 24 in. stroke, designed for 200 revolutions at 200 lbs. initial pressure.

It was believed by the Navy authorities that vessels of the amended design could be kept within the limits of the original Congressional appropriation of $1,500,000 for each vessel and so the original awards could stand. The contractors have to be heard from in this connection, and at this time the matter is under discussion.

The annual meeting of the American Society of Mechanical Engineers will take place at the Society's headquarters in New York, November 29 to December 2, inclusive. An extensive programme of scientific and technical papers has been arranged, and the meeting promises to be fully up to the usual standard of this Society.

EDUCATIONAL DEPARTMENT.

CALCULATIONS FOR ENGINEERS—AN AID TO CANDIDATES FOR MARINE PAPERS—III.

BY DR. WILLIAM FREDERICK DURAND.

§ 6. RATIO AND PROPORTION.

[2] Compound Proportion.

In many cases the result depends on more than one changing condition. In such case the problem is treated by the method of compound proportion as illustrated in the following example.

When coal is $4.20 per ton the fuel bill for a ship requiring 34 tons per day on a voyage of 2,100 miles is $1,020. At the same speed what would be the bill on a 2,800-mile voyage, with coal at $3.60 per ton, and a consumption of 40 tons a day?

The resulting cost evidently depends on three conditions, and the proportion is stated as follows:

$$\begin{array}{rrcl} & & 3.60 & : \quad 4.20 \\ \text{Ans.} : 1020 :: & 40 & : & 34 \\ & 2800 & : & 2100 \end{array}$$

This consists really of three simple direct proportions each stated exactly according to the rules already given as may be readily seen. For the solution of such a proportion the same rules may be used, but the "product of the means" or the "product of the extremes" must here be understood to mean the product of all the separate numbers forming these terms.

Thus for the foregoing proportion we multiply together the means and divide by the extremes, giving as follows:

$$\text{Ans.} = \frac{3.60 \times 40 \times 2800 \times 1020}{4.20 \times 34 \times 2100} = \$1371.43.$$

Cancellation can usually be made to assist in the reduction of such expressions, and we thus readily find the answer as stated.

Where the relations are such that the answer is inversely proportional to certain of the varying conditions, the ratio involving these conditions must, of course, be so stated as to make this part of the proportion inverse instead of direct. In fact, each of the ratios in the second part of the proportion should be carefully examined in order to make sure whether it should be stated *direct* or *inverse*.

Example involving both direct and inverse proportion:

When coal is $4.00 per ton, the fuel bill for steaming a certain distance at a speed of 12 knots, with a ship requiring 48 tons per day, is $1,800. For the same distance, what would be the bill if the ship requires 40 tons per day, with coal at $3.20 per ton and a speed of 10 knots?

The statement would be as follows:

$$\begin{array}{rrcll} & & 3.20 & : 4.00 & \text{(direct)} \\ \text{Ans.} : 1800 :: & 12 & : & 10 & \text{(inverse)} \\ & 40 & : & 48 & \text{(direct)} \end{array}$$

In this case we have:

$$\text{Ans.} = \frac{1800 \times 3.20 \times 12 \times 40}{4.00 \times 10 \times 48} = \$1440.$$

Problems in Proportion.

(1) An engine with 34 lbs. mean effective pressure gives 1,400 I.H.P. All other conditions remaining the same, what would the engine give with 39 lbs. mean effective pressure?

Ans. 1,606 I.H.P.

(2) An engine making 98 revolutions per mt. gives 1,800 I.H.P. All other conditions remaining the same,

what would the engine give if the revolutions were 90?

Ans. 1,653 I.H.P.

(3) An engine with stroke of 3 ft. gives 900 I.H.P. All other conditions remaining the same, what would be the power with stroke of 42 in.?

Ans. 1,050 I.H.P.

(4) An engine cylinder whose area is 1,200 sq. in. gives 800 I.H.P. All other conditions remaining the same, what would be the power with an area of 1,000 sq. in.?

Ans. 666.67 I.H.P.

(5) A given engine has mean effective pressure 33. revolutions 120, stroke 42 in., and gives 1,800 I.H.P. Other conditions remaining the same, what would be the power with a mean effective pressure of 38, revolutions of 100 and stroke of 4 ft.?

Ans. 1,974 I.H.P.

(6) A boiler with tubes 7 ft. long, and 2 3-4 in. diam. has 2,168 sq. ft. of tube heating surface. What would be the surface, with the same number of tubes, 7 ft. 6 in. long and 2 1-2 in. diam.?

Ans. 2,112 sq. ft.

(7) An engine with 34 lbs. mean effective pressure and 98 revolutions develops a certain power. If the mean effective pressure were 38 lbs., what revolutions would give the same power?

Ans. 87.7 rev.

(8) A given engine has a mean effective pressure 33, revolutions 120, stroke 42 in., and develops a certain power. With mean effective pressure of 38 and stroke of 3 ft., what would be the revolutions for the same power?

Ans. 121.6 rev.

(9) A pump making 40 double strokes per mt. can empty a tank in 1½ hrs. In what time could the same pump, making 30 double strokes per mt., empty a second tank, 20 per cent larger than the first?

Ans. 2.4 hours.

(10) A propeller at 100 revolutions and 20 per cent slip gives a speed of 18 knots. What will be the speed at 120 revolutions and 25 per cent slip?

Ans. 20.25 knots.

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§ 7. EVOLUTION AND INVOLUTION.[5]

[1] EVOLUTION is the operation of raising a number to successive powers, or of multiplying it into itself as a factor a certain number of times. The number of times the number is used as a factor is called the *index* of the power, and is indicated by a small figure written to the right and above as follows:

$$4^2 = 4 \times 4 = 16$$
$$5^3 = 5 \times 5 \times 5 = 125$$
$$3^5 = 3 \times 3 \times 3 \times 3 \times 3 = 243$$

Evolution involves, therefore, simply continued multiplication. The powers most commonly used by the engineer are the second and third, or *square* and *cube*, as they are commonly called.

[2] INVOLUTION is the inverse of evolution, and consists in finding a number which, used on itself as a factor a certain number of times, will produce a *given* number. The former is then called the root of the latter. The number of times the root is used as a factor is called the *index*, and is represented either by writing this number at the upper left hand angle of the sign of involution, $\sqrt{\ }$, or by the use of a fractional index, written as in evolution. The roots most commonly used by the engineer are the *square* and *cube* roots, corresponding to the second and third or square and cube powers. When square root is indicated by the symbol $\sqrt{\ }$, it is customary to omit the 2 from the upper angle. Thus we have:

$$\sqrt[3]{27} \text{ or } 27^{\frac{1}{3}} = 3 \text{ because } 3 \times 3 \times 3 = 27.$$

$$\sqrt{49} \text{ or } 49^{\frac{1}{2}} = 7 \text{ because } 7 \times 7 = 49.$$

Occasionally the engineer has to deal with the index $\frac{2}{3}$, which is simply a short way of indicating two operations. (1) Raising to the square. (2) Extracting the cube root. Thus $64^{\frac{2}{3}}$ means the 3d root of the 2d power of 64, or the 2d power of the 3d root of 64. Either order of operation will give the same result. Thus:

$$64^{\frac{2}{3}} = \sqrt[3]{64 \times 64} = \sqrt[3]{4096} = 16$$

$$\text{or } 64^{\frac{2}{3}} = \left(\sqrt[3]{64}\right)^2 = 4^2 = 16$$

---

[3] To Extract the Square Root.

This is best illstrated by an *example.* Find the square root of 746.2.

(1)	(2)
0	7·46.20 (27.316 +
2	4
-	
2	346
2	329
40	1720
7	1629
47	9120
7	5461
540	363900
3	
543	
3	
5460	
1	
5461	
1	
54620	

Rule[6]—(1) Point off the given number into periods of two figures each, beginning at the right or at the decimal point, if there is one, and in the latter case point both ways, adding ciphers on the right of the decimal as may be necessary to complete the periods. Thus:

Number	*Pointed Off.*
2643	26·43
867	8·67
424.362	4·24.36·20
.024	.02·40
.6	.60

(2) Write a 0 on the left, thus heading two columns (1) and (2), as shown. Find by trial the greatest number [2] which when squared is equal to or less than the left hand period. Put this on the right as the first figure of the root.

(3) Place this figure [2] under the 0 in col. (1) and add. Multiply the sum [2] by the root figure [2], and place the product [4] under the left hand period in col. (2). This product will be, of course, the square of the root figure. Subtract and bring down the next period for a partial dividend [346].

(4) Again place the root figure [2] on the left and add [4]. Annex a 0 and the result [40] will be a trial divisor for the next root figure.

(5) Divide and take on trial the resulting whole number for the next root figure [7].

(6) Bring down this figure [7] in col. (1) under the 0. Add and multiply the sum [47] by the same root

5. Hand books with convenient tables of powers and roots are so common at the present day that the engineer has small use for the actual operations of raising to powers or of extracting roots. In practice the use of such tables is always counseled as tending toward accuracy, and speed. The importance of these operations, however, merits a brief outline of the process as given herewith.

6 The brackets [ ] contain the numbers in the example which correspond to the special indication of the rule, and thus make its application to the given case more easily followed.

figure [7] and place the product [329] in col. (2) under the partial dividend. Subtract and bring down as before for a new partial dividend [1720].

(7) Place the root figure [7] again in col. (1), add and annex a cipher for a new trial divisor [540].

(8) Find another root figure as before and proceed in this manner till as many figures are obtained as are desired.

If the product found, as in (6), is greater than the partial dividend, it indicates that the trial figure was too great, and the next lower must be taken. If at any time the trial divisor is greater than the partial dividend, enter a 0 in the root, bring down the next period in col. (2) for a new partial dividend, annex a 0 on the right in col. (1) for a new trial divisor and proceed as before.

[4] To Extract the Cube Root.

This is best illustrated by an example. Find the cube root of 12.593.

(1)		(2)	(3)
0		0	12 593 (23.26
2		4	8
2		4	4593
2		8	4167
4	66	1200	426000
2	3	189	320168
60	690	1389	10583200
3	2	198	
63	692	158700	
3	2	1384	
	694	160084	
	2	1388	
	6960	161472 0	

Rule[7]—Point off the given number into periods of three figures each, beginning at the right or at the decimal point, if there is one, and in the latter case point both ways, adding ciphers on the right of the decimal as may be necessary to complete the periods. Thus:

Number	*Pointed Off.*
1724	1·724
17243	17·243
17.24	17.240
.64	.640
.0032.....	.003·200

(2) Write ciphers on the left thus, heading the columns (1), (2) and (3) as shown. Find by trial the greatest number [2] which when cubed is equal to or less than the left hand period. Put this on the right as the first figure of the root.

(3) Place this figure under the 0 in col. (1), add, multiply sum [2] by root figure [2], place product [4] in col. (2), add, multiply sum [4] by root figure [2] again, and place product [8] in col. (3) under left hand period. This product will be, of course, the cube of the root figure. Subtract and bring down the next period for a partial dividend [4593].

(4) Again place the root figure [2] in col. (1), add, multiply sum [4] by root figure, put the product [8] in col. (2), and add [12].

(5) Again place root figure [2] in col. (1) and add as before [6].

(6) Annex one 0 to the result in col. (1) [60] and two 0s to that in col. (2) [1200]. The latter is then a trial divisor for the next root figure, which is thus seen to be probably 3.

(7) The same process of bringing down, adding and multiplying in cols. (1), (2) and (3) is then repeated as just described, and as shown in the example. Continue in this way until as many figures of the root are found as are desired.

If the final product to be entered in col. (3) is greater than the partial dividend, it indicates that the trial figure was too great, and the next lower must be taken. If at any time the trial divisor is greater than the partial dividend, enter a 0 in the root, bring down the next period in col. (3) for a new partial dividend, annex one 0 in col. (1) and two 0s in col. (2) for a new trial divisor, and proceed as before.

It will be noted that in these methods for square and cube root the former requires for each root figure two operations in col. (1) and one in col. (2), while the latter similarly requires three operations in col. (1), two in col. (2) and one in col. (3). Care should be taken that none of these are omitted, and that the entire process is carried through with regularity and order.

[7] The brackets [ ] contain the numbers in the example which correspond to the special indication of the rule, and thus make its application to the given case more easily followed.

§ 8. MATHEMATICAL SIGNS, SYMBOLS AND OPERATIONS.

[1] Mathematical signs are simply shorthand methods of indicating mathematical language. Those most commonly met with are the following:

\+ The sign of addition called *plus*. This means that the two numbers or quantities between which it is placed are to be added. Thus 12 + 3 is read 12 plus 3 and means that 12 and 3 are to be added, the result being 15.

— The sign of subtraction called *minus*. This means that the number or quantity which follows the sign is to be subtracted from that which precedes it. Thus 12 — 3 is read 12 minus 3 and means that 3 is to be taken from 12, the result being 9.

× The sign of multiplication. This means that the two numbers or quantities between which it is placed are to be multiplied together. Thus 12 × 3 is read 12 times 3 or 12 multiplied by 3, the result being 36.

÷ The sign of division. This means that the number or quantity which precedes the sign is to be divided by that which follows. Thus 12 ÷ 3 is read 12 divided by 3, the result being 4.

/ A sign of division. A fraction is really a mode of expressing division, and a common way of writing a fraction all in one line is to make use of the oblique line. Thus 12/3 means the same as $\frac{12}{3}$ or 12 ÷ 3 or 4. Frequently the horizontal line — as shown is used, thus: ½, 1—2 all indicate one-half, or 1 divided by 2. The horizontal line used in this connection must not be confused with the *minus* sign, usually the sense is plainly indicated by the connection in which it is used.

. Placed before and in line with the bottom of a number is a decimal point, showing that the number is the numerator of a fraction which has some power of 10 for its denominator; as .1 = $\frac{1}{10}$, .25 = $\frac{25}{100}$, which reduced to its lowest terms is 1-4. See chapter on decimal fractions.

: The sign of ratio. This signifies the ratio or numerical relationship of the two quantities between which it is placed, and is equivalent to a sign of division, since the quotient of the first quantity divided by the second is the measure of the ratio between them. Thus 12 : 3 is read the ratio of 12 to 3 or 12 is to 3. and the real measure of this ratio is 12 ÷ 3 or 4.

: : The sign of proportion or equality of ratios. This sign is placed between two ratios and signifies that they are equal. Thus 12 : 3 : : 20 : 5 is read 12 is to 3 as 20 is to 5, or the ratio of 12 to 3 equals the ratio of 20 to 5. This is seen to be the case since 4 is the measure of each ratio.

= The sign of equality. This signifies that the two quantities separated by the sign are equal in value. Thus 12 ÷ 3 = 4 is read 12 divided by 3 equals 4, and thus states the equality between the two sides of the relationship.

Equation. Two quantities or expressions related by the sign of equality, =, form an equation. Thus

$$4 + 2 = 6$$
$$a = 3$$
$$a + b = c$$

( ), [ ], { }. *Parentheses* or *brackets.* These symbols mean that all numbers or quantities within a parenthesis or pair of brackets are to be sidered as one quantity and thus treated in all numerical operations. Thus 2 (3 + 4) means that 3 + 4 is to be taken as the single quantity 7, and then multiplied by 2. Similarly

$$2\ (3 + 4 - 2) = 10$$
$$3\ [16 - 2\ (3 + 4 - 2)] = 18$$

NOTE: The sign of multiplication, ×, is often omitted between a number and a parenthesis or bracket containing a quantity into which it is to be multiplied, as in the expressions here shown.

In some cases a bar or *vinculum* is drawn over numbers thus to be taken together. Thus $2 \times \overline{3 + 6}$ means 2 multiplied by the quantity 3 + 6, or 2 × 9, or 18. The difference between $2 \times \overline{3 + 6}$ and 2 × 3 + 6 or 12 will be noted. In reducing quantities thus affected by the signs +, —, ×, ÷ and connected by brackets, the difference in significance between the signs +, — and × ÷ must be carefully noted. Thus 2 × 3 + 6 means 2 times 3 added to 6 or 12 and not 2 times (3 + 6) or 18. As a general principle, it may be remembered that the signs + and — effect a separation of the expression into separate terms, while the signs × and ÷ bind together the two quantities between which they stand into a single term.

Examples—These principles are further illustrated by the following:

$$3 \times 16 - 2 \times 3 + 4 - 2 + 4 \times 3 - 1 = 55$$
$$3\ [16 - 2 \times 3 + 4 - 2 + 4 \times 3 - 1] = 69$$
$$3\ [16 - 2\ (3 + 4) - 2 + 4 \quad (3 - 1)] = 24$$
$$3\ [16 - 2\ (3 + 4 - 2) + 4 \quad (3 - 1)] = 26$$

$\sqrt{\ }$ This sign placed over a quantity denotes the extraction of a root. If no number is placed at the upper left angle, it denotes the square root; otherwise a root corresponding to the index thus indicated. Thus $\sqrt{49}$ denotes the square root of 49 or 7, $\sqrt[3]{27}$ denotes the cube root of 27 or 3, $\sqrt[4]{16}$ denotes the fourth root of 16 or 2, etc.

3^2 or 4^3 or a^4. A small number written to the right and above another number or quantity is called an *index* or *exponent*, and signifies that the lower number or quantity is to be used as a factor on itself a number of times equal to the index. Thus:

$$3^2 = 3 \times 3 = 9$$
$$4^3 = 4 \times 4 \times 4 = 64$$
$$a^4 = a \times a \times a \times a$$

′ ″ These signs set to the right and above any figure or figures (superior) signify feet and inches. These signs are much used in dimensioned drawings.

⊥ Signifies *perpendicular to.*

∠ Signifies *angle.*

∟ Signifies *right angle.*

∴ Signifies *hence* or *therefore.*

∵ Signifies *because.*

π Denotes the ratio between the circumference and diameter of a circle. Its value is usually taken as 3.1416.

□ Square sometimes used in denoting pressures; as 220 lbs. per □″ or per square inch.

% Signifies *per centum* or *per hundred.*

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—XIV.

BY WM. BAXTER, JR.

The skeleton diagrams of switch boards, shown in Figs. 65 and 66 of the last article will greatly facilitate the understanding of the explanations of Figs. 67 and 68, which represent arrangements of boards designed to fulfill the conditions stated as necessary in the discussion of the first named figures. Fig. 67 represents only one of the numerous ways in which a switch board may be arranged to connect a number of generators with a single distributing system, and Fig. 68 is likewise one of the many arrangements that can be used when the generators are required to feed into two independent distributing systems.

In Fig. 67, it will be noticed that there are four bus bars, while in Fig. 65, which is intended to meet the same conditions, there are only three. This additional bar does not in any way affect the general arrangement, and as will be seen presently when its office is explained, it could be dispensed with if we were satisfied to get along without the volt meter *V′* and the ammeter *A M′*.

The bus bar *I* is the equalizing bus, and, as will be noticed, to it are connected the top brushes of the three generators, by the wires *c*. *B B B* are circuit breakers and *S S S* are switches, thus each generator is provided with means for disconnecting it from the board, and also with a protective device that will automatically open the circuit whenever the current becomes dangerously strong. Each machine is provided with a volt meter *V* and an ammeter *Am*, both instruments being arranged to be permanently in the circuit. By means of these, the current strength in each generator is always indicated and also the voltage. The current from each generator coming from the lower brush passes by the wire *a*, first through the ammeter, and then through the circuit breaker *B* and then through the switch *S*, finally reaching bus *3*. *D D D D D* are circuit breakers placed in the individual external circuits, and *S′ S′ S′ S′* are switches by means of which these circuits can be connected or disconnected from the board. Supposing the *S′* switches to be closed, the current after reaching bus *3* from the generator will pass through the circuit breakers *D* and the switches *S′* to the external circuits, as indicated at the last right hand switch, the current leading out through the wire *f* and returning through *g*. As will be seen the side of the circuit breaker *D* and the switches *S′* to which wire *g* returns the current, connect with bus *4*, and this connects with bus *2* through the ammeter *Am′*. From the position of this ammeter, it will be seen that all the current that passes from bus *3* through the external circuit to bus *4* must pass through it to bus *2* in order to get back to the generators, for bus *4* is not connected with any other part of the system. Such being the case, ammeter *A′ M* measures the whole current developed by all the machines. The volt meter *V′* is connected with buses *3* and *4*, and as the latter is the last point the current reaches before passing to the external circuit, and the former is the first point reached upon the return, it follows that this volt meter registers the actual voltage of the current as it leaves the switch board. From this it will be understood that bus *4* is required simply because *V′* and *A′ m* are used, if they were discarded bus *4* could also be discarded, as then the right hand side of the circuit breakers *D D* could be connected with bus *3* as shown and the other side with bus *2*, from which the current passes direct to the generators through wires *b*. The volt meters *V* are connected to each individual generator circuit at the points *e* and *d*. These volt meters are not indispensible, and when it is desired to practise economy, one instrument may be made to serve for all the

generators, by simply running wires *e* and *d* to it from each generator circuit and providing a small switch by means of which the instrument can be connected with any one pair of wires. These volt meters are very important in starting up a generator, therefore at least one must be used, but as it is not specially advantageous to have them in circuit all the time, in the majority of cases only one volt meter is used for any number of generators, with a switch as above explained for connecting it with any desired machine. The field rheostats are placed at the bottom of the board, as shown at *R R R*, the rheostat proper being back of the board, the only part appearing upon the surface being the hand wheel *w*, by means of which it is manipulated.

The switch board shown in Fig. 67 is only adapted to cases where there is one distribution system; when there are more than one an arrangement such as

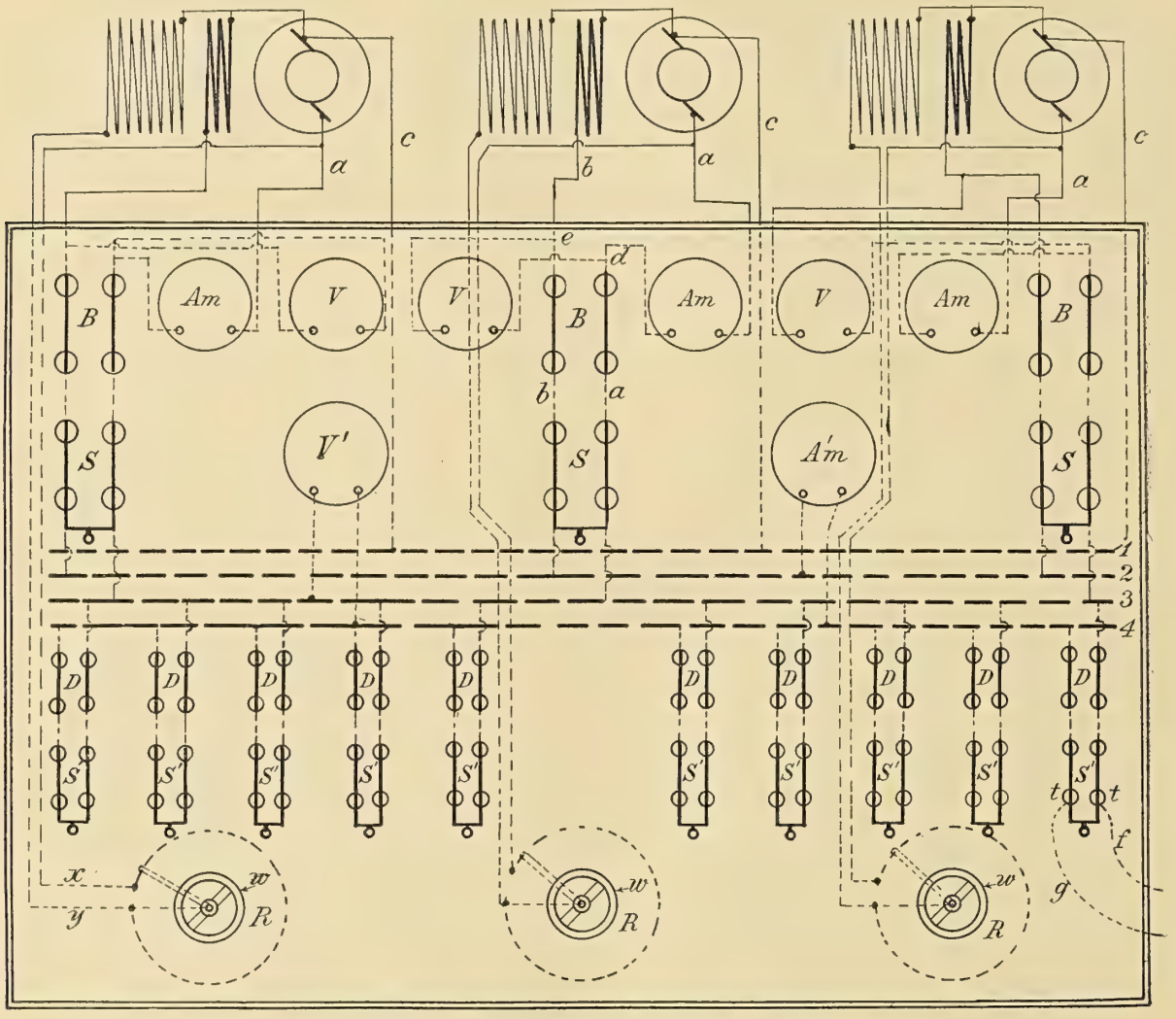


DIAGRAM OF DYNAMOS AND SWITCHBOARD. FIG. 67.

shown in Fig. 8 must be used. In this diagram the volt meters and ammeters, as well as the circuit breakers and switches belonging to the external circuits have been omitted for the sake of simplicity, but from the explanations given in connection with Fig. 67, the manner in which they should be connected will be readily understood. In this last arrangement it will be noticed that the generators do not connect directly with the bus bars, but, instead, with the center row of connections of the switches *S S S*. The right hand terminals of these switches connect with the upper set of buses and the left hand set with the lower buses. The circuit breakers in the individual generator circuits are shown at *B B B*. As in Fig. 67, the regulating rheostats are located at the bottom of the board, as shown at *R R R*. With the switches in the position shown in the diagram, the handles *L* connect the center contacts with the *s* set on the right hand side, and if we trace the circuit thus formed we will find that starting from any generator by way of wire *a* we reach the lower contacts of the switch, which connect with the bus bar *3*. The opposite wire from the generator, wire *b*, runs to the top contacts and thence to bus *2*, while the equalizing wire *c* runs to bus *1*. If the switch lever *L* is thrown to the left, the generator will be connected with the lower set of buses. From this it can be seen that any one of the generators can be connected with either set of buses. If it is desired to operate the whole as one system, it can be done by throwing the lever of the switch *S'*, which will then connect the two sets of buses.

If it is desired to connect the external circuits permanently with one or the other set of bus bars, switches and circuit breakers such as shown at *D D* and *S' S'* in Fig. 67 can be used, but ordinarily it would be preferable to have them so arranged that they may be transferred from one system to the

other. When such an arrangement is desired, the switch must be of the same construction as the *S* switches of Fig. 68, the external line terminals being connected with the central contacts, and the bus bars with the side contacts. The external circuits, however, only have to connect with the *2* and *3* bus bars, therefore the switches for this purpose will only require two contacts in a row, instead of three. In order that only one circuit breaker may be required for each circuit it is necessary to place the switch between it and the bus bars, just as the main switches *S* are placed between the circuit breakers *B* and the bus bars. In Fig. 68 it will be noticed that there is an equalizing bus bar (1) in each set, and that the switches are made so as to disconnect this

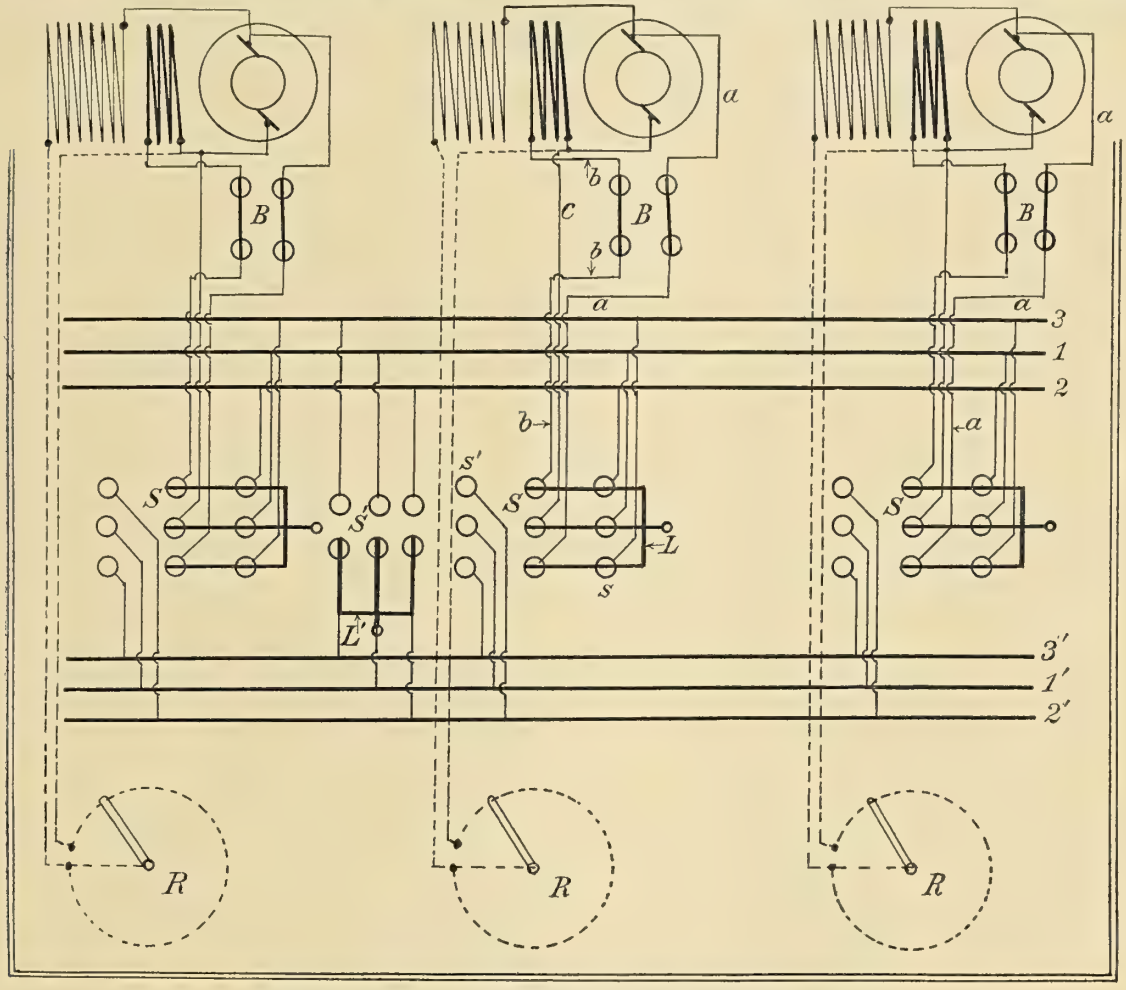


DIAGRAM OF DYNAMOS AND SWITCHBOARD.—FIG. 68.

as well as the main line wires. Considering the part that the equalizing bus plays it might occur to some that this is a needless complication, and that one such bar with switches, that would only change the connections of buses *2* and *3*, would be sufficient. In some cases such an arrangement would meet all the requirements, but with only one equalizing bar the generators when transferred from one system to the other would not be entirely disconnected; therefore, in cases where it is desirable or necessary to operate each set entirely disconnected from the other there must be an equalizing bus in each system. The American line steamship St. Paul, which is arranged with independent external systems that are independent, is operated with a single equalizing bus, and has other simplifications which will be readily understood from the description that will be given in the next article.

ENGINEERS' DICTIONARY.—XII.

Crank.—In general a member of a machine having rotary motion and joined by means of a *connecting rod* to a part having straight line motion. In the marine engine the crank receives its motion from the lower end of the connecting rod and transmits it to the line shaft and thence to the propeller. Fig. 43 shows a three throw built-up crank-shaft or a crank-shaft with three cranks of which each consists of a *crank-pin*, two *crank webs* or *slabs* and the connecting portions of shafting. For many years crank-shafts in mercantile practice have commonly been of the *built-up* variety. In a built-up crank-shaft the parts are made separately and are secured by shrinking the webs on the pins and pieces of shafting, and fastening by keys. In more recent practice to an increasing extent crank-shafts are made of forged steel either in one continuous forging or in sections secured by couplings, one section to each crank. In the higher grades of practice the pins and pieces of shafting are also frequently made hollow in order to save weight, and to give an opportunity to inspect the inner surface of metal and thus detect flaws which might escape an inspection of the outer surface alone Fig. 44 shows a crank-shaft of a destroyer forged hollow in one piece (including the eccentric sheaves) of nickel steel.

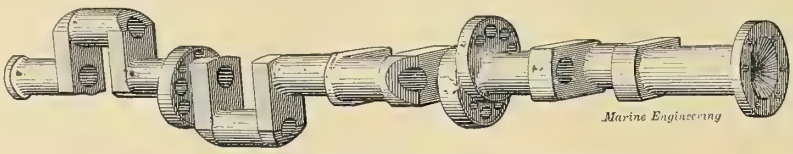
Crank-Shaft.—The name given in a marine engine to the collection of cranks and intermediate connecting pieces of shafting. See *crank*.

Crank-Pit.—The space below the bed-plate of a marine engine directly underneath the crank, sometimes

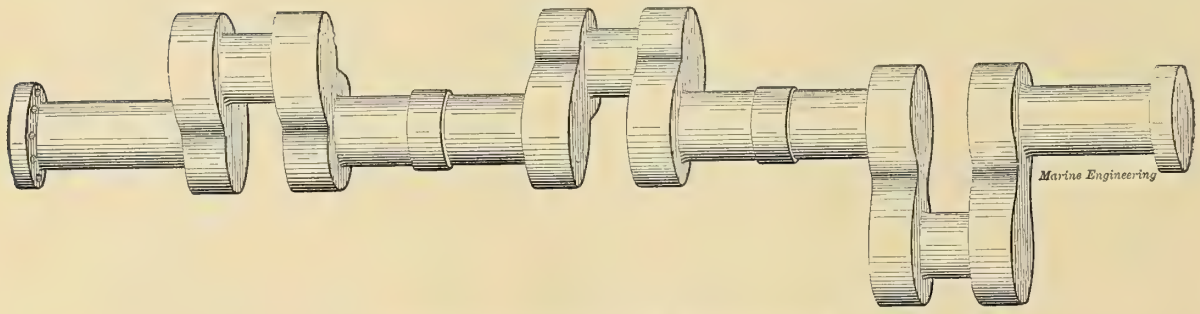
hollowed out specially to provide the necessary amount of clearance.

Damper.—A plate of thin sheet metal in the funnel or the uptake, and so hung that it may be turned more or less completely across the passage of the waste gases, thus checking the draft and decreasing the rate of combustion. When each boiler has a damper in its own uptake, the fires can be cleaned and the tubes swept without interfering with the draft of the other boilers.

Dash-Plate or *Scattering Plate.*—A plate fitted in a jet condenser just under the water discharge, usually pierced with many small holes, and intended to scatter the water in the form of a spray and thus lead to a more ready and intimate mingling of the water and vapor. A plate for the somewhat similar purpose of



HOLLOW FORGED CRANK SHAFT IN ONE PIECE.—FIG. 44.



THREE THROW BUILT-UP CRANK SHAFT.—FIG. 43.

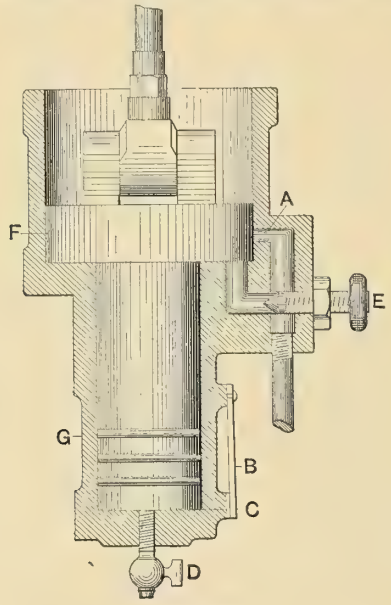


FIG. 45.

distributing the vapor in a surface condenser is sometimes known by the same term. See also *Diaphragm Plate.*

Dash Pot.—A device as shown in Fig. 45 for controlling or checking the sudden motion of a moving piece and bringing it gently to rest. It is largely used on "disengaging" valve gears; that is, valve gears in which at the point of cut-off the valve is released by the valve mechanism and allowed to drop by gravity or drawn quickly by spring or vacuum toward the closed position. This sudden motion is then arrested by the dash-pot and the valve is brought gently to its position of temporary rest. All such devices act by cushioning a piston upon air or by allowing a small amount of leakage of air or liquid past a piston or plunger, according to the circumstances of the motion to be controlled. In the dash-pot pure and simple, the object is to control rapid fluctuations of motion as here noted. When fitted with disengaging valve gear, however, the same device usually contains a second piston or plunger underneath which a vacuum is formed for giving to the valve the quick initial start. In the figure the upper piston cushions on the air which is shut in by its passage across the port A, while the vacuum is formed beneath the plunger G. The leakage is controlled by the valve E. The recoil cylinders on modern gun mounts are a special form of oil dash-pot.

Dead Plate.—In firing with bituminous or semi-bituminous coal it is often the custom to first charge the coal on the front of the furnace and allow it to remain there until the volatile elements are distilled away by the heat and burnt as gas, after which the coal is shoved back over the fire, where the residue burns as carbon. Where furnaces are specially arranged for this mode of firing, the grate bars do not extend to the door or front of the furnace, but instead there is left a space of 15 or 18 inches occupied by a plate upon which the fresh coal is placed. This is known as the *dead-plate.* Even where there is no especial provision for burning bituminous coal, the same name is often given to the plate on which the front ends of the grate-bars rest.

Dead-Centers or *Dead-Points.*—The two points in a revolution when the center lines of the connecting-rod and of the crank-arm are in the same line, and in consequence when there is no tendency from the piston to turn the crank arm in either direction. With the ordinary engine this takes place when the piston is at its extreme travel at one end or the other.

Delivery, *Cock, Valve, Pipe, etc.*—Any cock, valve or pipe, through or by means of which a delivery of something (usually a liquid, vapor or gas) is effected.

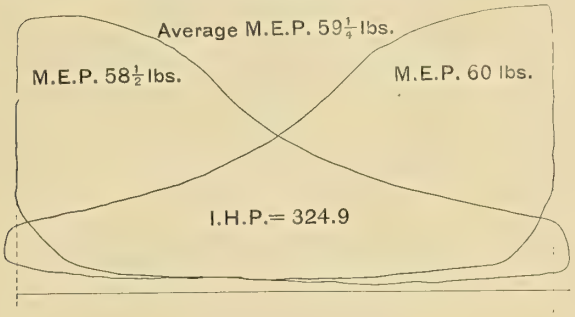
Diaphragm Plate or *Division Plate.*—A plate in a surface condenser for distributing the steam more uniformly throughout the internal volume (See Fig. 32). Plates or partial partitions in certain forms of separators are also known under the same name.

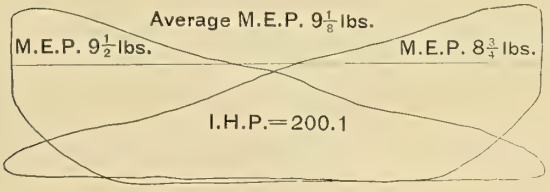
QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Please figure out horse power of cards, and also I would like to hear any criticism. ENGINEER.

A.—The data you send is incomplete. To get the horse power exact it would be necessary to work up the power at each end of the cylinder, as the bottom of the piston is reduced in area by an amount equal to the sectional area of the piston rod. In this case the cards do not indicate the bottom or top end, nor is the diameter of the piston rod given, so we have taken the average of the mean effective pressure at both ends. In most cases the figures thus deduced are very close





to the exact figures. The high pressure card was carelessly taken, for both ends do not come exactly above each other, as shown by the dotted lines. The valve could stand a little more lead, also a reduction in exhaust lap to allow an earlier release, which would give a more even exhaust line. The admission line is very near boiler pressure, but the cut off is bad, as the pressure drops 25 lbs. to the point of cut off. This, no doubt, is due to lack of port opening. The low-pressure card is fairly good, but would be improved by a little more lead. The distribution of power in the engine is very bad, the high pressure cylinder developing over 50 per cent more power than the low pressure, showing that the engine is not runnnig under economical conditions. The pressure in the low pressure receiver is not stated, but judging from the cards it must be about seven pounds. This is far too low for a compound engine of this size and cut off. If the low pressure cylinder is equipped with an independent linking device, it ought to be linked up so that the receiver pressure rises to about 14 pounds; the high pressure remaining undisturbed. Then the mean effective pressure in the high pressure cylinder will be about 48 pounds and in the low pressure about 12 pounds, and the powers in both cylinders will be equal. The power in the two cylinders would be equal with the low pressure cylinder set as shown, if the cut off in the high pressure cylinder was about 18 in., instead of 13 in.

Q.—Kindly inform me whether wetting down coal to be fed to a boiler is coal-saving, or a saving in any sense? If so, state in what way and with what kind of coal, and if not, why not? A SUBSCRIBER.

A.—The addition of water to coal always means a loss in itself, because the water absorbs heat in becoming vapor, and this heat is carried away with the products of combustion. It is sometimes claimed, because the hydrogen and oxygen in the water may become separated and the hydrogen then burn at a later time, or because the vapor may unite with carbon to form water gas, which burns at a later time, that there is a real gain in heat. This, however, is not so. There is heat absorbed in the separation of the hydrogen and oxygen of the vapor, and when the hydrogen burns or unites again with the oxygen, there is exactly the same amount given out. Similarly heat is absorbed in the formation of water gas, and when it is burned the net result is just what would have resulted from the combustion of the carbon part of it.

In short, you cannot use water for fuel any way you may try, and the heat absorbed in turning the water into vapor will be necessarily lost, with the products of combustion, into the air.

On the other hand, the presence of moisture in the fuel may indirectly react on the character of the combustion, or on the way in which the fires may be worked, so as to make it possible to get more out of the coal than if dry fuel were used. Wetting the coal will also decrease the amount which may be blown unconsumed up the funnel by a lively draft. Wetting the coal is believed by many to influence the caking of bituminous coal as well as the formation of clinker. Also the formation of hydrogen or of water gas may distribute the combustion differently throughout the furnace and combustion chamber, and thus lead to a better absorption of heat than if dry fuel were used.

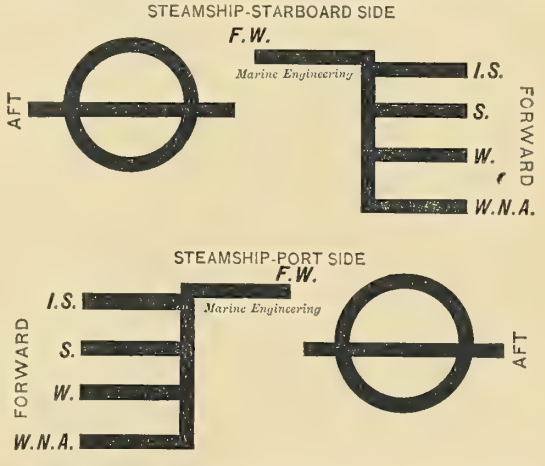
In this way, then, wetting down the fuel may in itself make it possible to get more out of certain grades of coal, may make it possible to better work the fires, or may give a better distribution of combustion and so give a better economical result. The final effect will be therefore the balance of this possible gain and the certain loss first described. In some cases doubtless the net result is a small gain, though, as a general rule, it can hardly be expected that wetting the fuel will result in a net gain of really sensible amount, while, perhaps, more probably the operation may result in a slight loss.

Q.—Please give and explain draught marks noticed particularly on English tramp steamers. E. B.

A.—The marks as they appear on all British steam vessels other than very small coasters, fishing vessels and yachts are shown here in the engravings. The meaning of the initial letters in the scale is:

F W	Fresh water.
I S	Indian summer.
S	Summer.
W	Winter.
W N A	Winter North Atlantic.

The marks are prescribed and applied by the British Board of Trade under authority from Parliament. The location of the



fresh water mark is such that a vessel with load line at F. W. in fresh water will float at S in salt water. The Indian summer mark is used by vessels in trade in the far east at certain seasons of the year. The circular disc is required to show distinctly, and to be 12 in. dia., with a horizontal line 18 in. long through the center.

The marks are located on each side amidships, in white or yellow on a dark ground or in black on a light ground.

RECENT PUBLICATIONS.

THE HEAT EFFICIENCY OF STEAM BOILERS, LAND, MARINE AND LOCOMOTIVE, *with Tests and Experiments of Different Types, Heating Value of Fuels, Analysis of Gases, Evaporation and Suggestions for Testing Boilers.* By Bryan Donkin, M.I.C.E. J. B. Lippincott and Co., Philadelphia, Pa. First Edition, 1898. Size, 7 1-2 by 8 3-4. Pages, 311. With numerous tables, plates and illustrations. Cloth, $8.00.

As might be expected from the author and his subject, this is an exceedingly interesting and valuable work. The getting of the most for the least expenditure has long been the study and aim of man. A slight consideration of the immense sums annually expended for coal, to be burned under the boilers of the world, would convince any one of the value or rather necessity of getting as large a percentage of heat as possible into the form of steam. The subject of heat efficiency becomes, therefore, of great importance. In steamships this is doubly necessary, not only as a question of economy in fuel consumption, but as affecting bunker space which could be profitably utilized for cargo. The author goes right into his subject, omitting all historical and scattering information in regard to boilers. In Chapter I, the different types of boilers are illustrated and their efficiencies noted. The heart of the volume lies in Chapters II and III, which are devoted to summaries of 425 experiments on various boilers. These tables are very full and complete, containing all the data of the tests as well as the calculated efficiencies. Boiler appurtenances, grates, stokers, feed water heaters, etc., receive attention in succeeding chapters. Transmission of heat through plates, smoke and its prevention; suggestions and notes for boiler tests conclude the book. The volume is well printed, and for an English work the illustrations are good. An excellent index of both subject matter and illustrations enhances the value of the book, which unquestionably would be a most valuable addition to the library of every up-to-date practical engineer.

"The Nation's Navy," by Charles Morris, is an excellent compilation for the purpose outlined by the author in his preface. A book for those in whom recent events have awakened a proper desire to know more about American ships of war, and all the modern paraphernalia of destruction which the word Navy embraces. The daily newspaper, or literary periodical refers to battleships and guns, torpedoes and explosives, in a familiar way, while possibly the ordinary intelligent reader knows little of these deadly necessaries beyond the names. To tell him in an interesting non-technical way all about them is the purpose of the author; an ambitious one when to this he adds a concise history of the Navy, and frequent digressions to show the concurrent development in naval circles abroad. In 100 pages the reader is carried along at high speed from the fight at Machias in 1775, through the brilliant deeds of American naval officers in European waters, the fierce fights of 1812, the subsequent battles with sea rovers near home, and the momentous naval engagements of the Civil War, to the beginning of the Spanish war. In the second part the evolution of the iron-clad is traced from Fulton's Demologos, through the inventions of Stevens and Ericsson, to the modern type of ship, and then in succession the American monitor, battleship, cruiser, torpedo boat and submarine vessel are turned inside out for the benefit of the land-dwelling reader. Another division covering armor and armament, powder and projectiles, submarine and land defenses, brings one to the last chapter on "The Navies of the Nations." When all this is crowded into 330 pages the result must be compression, in which many refinements of description are squeezed out; but that is probably just what his reader will admire, and there are lots of admirable features about the book, including the half-tone engravings of well known ships. The author is patriotic, so much so indeed, that at times patriotism collides with accuracy, though the latter is not always on its course. As examples are the statements that "repair ships" and the "interrupted screw" are American inventions, and that the latter is "alone used in the U. S. Navy, and is being adopted abroad." This would be news to Canet and Vickers. Of the other sort are statements that rapid-fire guns "are rarely employed for more than a few minutes at a time, and do not have the opportunity to become heated," and that the Vesuvius "fires projectiles charged with dynamite." Then there is a happy vagueness in the explanation that in the Turbinia "the recently-invented steam turbine is used, in which the impact of steam upon the face of *vans* turns the screw shaft, instead of high pressure being employed as in ordinary engines." These are minor details, however, and only show how excellent are the broader features of the book. It is up-to-date, full of facts, of unqualified interest and in makeup and binding, an artistic production. The publishers are the J. B. Lippincott Co., of Philadelphia. Price, $1.50.

A modern diagram chart for making a ready analysis of the movements of the slide valve is published by the Lunkenheimer Co., of Cincinnati, Ohio. It consists of a card upon which is printed a circle of degrees, and mounted concentrically within this is a movable paper circle with lines indicating the paths of the crank pin and eccentric. At one edge of the card a valve face with ports (its center corresponding with the center of the degree circle) is printed, and a separate card with straight edge extension represents a section of a valve. Other forms of face and valve can be substituted as required, and results in the setting of valves can be reached independent of any purely matematical work.

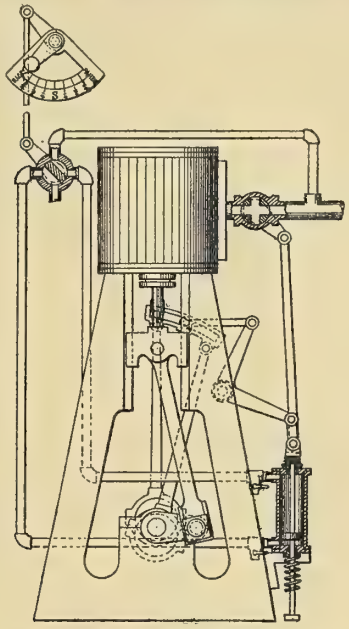
"The Book of the Ocean," by Ernest Ingersoll, is a remarkably clever compilation, combining a whole lot of technical information about ships and the sea, with lively historic narrative; an ideal book for the youth of the country. It contains over 270 pages and not an uninteresting paragraph, and the abundance of illustrations, drawn with artistic spirit, give it an additional attractiveness. To show the breadth of its purpose a glance at the table of contents is instructive: Ocean and its origin; wave tides and currents; building of ships; early voyages and polar explorations; warships and naval battles; sea merchants and pirates; yachting; dangers of the deep; fishing; sea plants and animals. It would be an ideal Christmas gift for a boy who had shown any interest in marine affairs, or, indeed, would induce an interest in the ocean even in a resident of the middle west. The type is bold and the printing in keeping with the reputation of the De Vinne Press. The book is published by The Century Co., New York, price $1.50.

Interest in present naval affairs has been intensified greatly by the recent operations in the Spanish war, and it is but a step back to the previous chapter in U. S. naval history—the Civil War. For the many who want to refresh their memory of the stirring events in the Sixties, or for those who wish to enjoy the story of those days as a first experience, Charles Scribner's Sons, of New York, have provided a handsome and compact set of volumes entitled: "The Navy in the Civil War." It consists of three volumes of about 250 pages each, each complete in itself, and yet forming a section complimentary to the others. The first book treats of "The Blockade and the Cruisers," and is by Prof. Soley, U. S. N.; the second book covers "The Atlantic Coast," by the late Rear Admiral Ammen, U. S. N.; the third book is about "The Gulf and Inland Waters," and is from the pen of Commander Mahan, U. S. N. The volumes are uniform in size and style, and each has an engraved frontispiece and various maps illustrating the text. Separately they are sold at $1.00 each; $3.00 for the entire set.

SELECTED PATENTS.

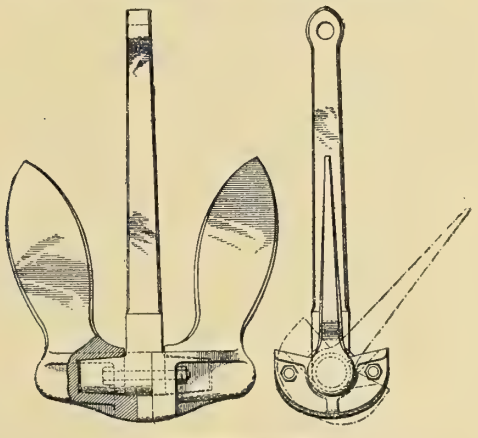
604,253. ENGINE-CONTROLLING DEVICE. *Alexander P. Loper, Stonington, Conn. Filed September 9, 1897.*

In an engine-controlling device the combination with the throttle-valve and the reversing-gear of an auxiliary cylinder containing a piston normally in a middle position in the cylinder the piston being connected with the throttle-valve and the reversing-gear, a valve connected with a fluid-pressure supply and



LOPER ENGINE CONTROLLER.

with the ends of the auxiliary cylinder to admit a fluid under pressure to either end of the cylinder to shift the piston, and means under the control of the operator for shifting the valve and indicating its position. An engine-controlling device, comprising an auxiliary cylinder containing a piston connected with a throttle-valve and with the reversing-gear of the engine, for actuating both simultaneously, a valve



BOWER'S ANCHOR.

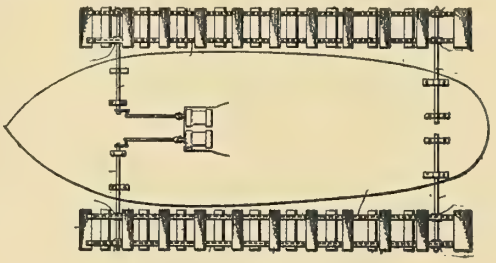
directly under the control of the operator, and connected with a supply and with both ends of the auxiliary cylinder, and springs connected with the piston-rod of the auxiliary cylinder, to hold the piston normally in a middle position. An engine-controlling device, comprising a quadrant having a pointer, a valve having its plug positively connected with the pointer, the valve being connected with a steam-supply and with an exhaust, an auxiliary cylinder connected at its ends with the valve, to permit of sending steam from the valve to either end of the cylinder, a piston contained in the cylinder, and having its piston-rod pressed on by springs, to normally hold the piston in a middle position, and means for connecting the piston-rod of the piston with the throttle-valve of the engine and with the reversing mechanism.

602,719. ANCHOR. *La Mont M. Bowers, Cleveland, Ohio. Filed September 21, 1897.*

In an anchor, the combination with the shank and cross-arm, of a separable fluke-head composed of two duplicate sections, and provided with interlocking lugs at their point of juncture, whereby the sections are locked against torsional strain in relation to each other, and are interchangeable. In an anchor, a shank provided with trunnions, in combination with a jointed or separable fluke-head, the sections of which are secured against pulling apart longitudinally, by bolts, and against torsional or lateral strain in relation to each other, by interlocking lugs. An anchor comprising the usual shank having frusto-conical trunnions on which the fluke portion rocks, in combination with a separable fluke portion, the sections of which are secured together longitudinally by bolts, and held against turning laterally in relation to each other by interlocking lugs.

599,050. CHAIN-PROPELLER. *William S. Winsor, St. Louis, Mo. Filed November 19, 1896.*

A combined ship propulsion and steering mechanism comprising independent shafts journaled in bearings at the front of the vessel and extending out from the sides, a plurality of sprocket-wheels secured to the outwardly-projecting portions of shafts, independent shafts journaled in bearings connected to the vessel at the rear, and likewise extending out from



WINSOR CHAIN PROPELLER.

opposite sides of said vessel, a plurality of sprocket-wheels secured to the shafts in alinement with the sprocket-wheels on the shafts at the front of the vessel, a plurality of sprocket-chains at each side of the vessel which chains run over the sprocket-wheels of the front and rear shafts, inclined blades or paddles connected to all the sprocket-chains at the respective sides of the vessel by angle-irons, and independent engines operatively connected to the shafts at the front of the vessel whereby the propelling mechanisms can be operated simultaneously or independently to propel or steer the vessel.

OBITUARY.

J. Taylor Gause, president of the Harlan & Hollingsworth Co., died at his residence in Wilmington, Del., December 1, from an attack of pneumonia.

John B. Coyle, who was prominently identified with New England coast steamship interests, died at his residence in Portland, Me., November 7, aged 57 years.

J. W. Keely, who claimed to have discovered a new force, and invented a motor to convert it into useful work, died in Philadelphia, November 18. For a number of years he used the motor for the extraction of money from credulous capitalists, apparently finding that its efficiency was greater for this purpose than for any application to industrial uses. He left papers, which, if properly interpreted, ought to make his successor rich.

TRADE PUBLICATIONS.

A neat desk blotter containing a suggestion of mechanical rubber goods is sent to all inquirers by the Boston Belting Co., 256 Devonshire St., Boston, Mass.

A 6 by 9 cardboard containing a picture in colors of the new World feed water heater is sent to all inquirers by the Robertson Mfg. Co., 218 Fulton St., New York.

Valves, planimeters, indicators and gauges are illustrated and briefly mentioned in a small folder issued by the American Steam Gauge Co., 36 Chardon street, Boston, Mass.

A picture is sent free by Captain M. De Puy, 19 South St., New York, showing the boat Paragon towing ten heavily laden canal boats around the point at West Point, N. Y. The picture is 7 by 10 in. in size.

Draughtsmen will find an interesting circular in one issued by Theodore Alteneder, 945 Ridge Ave., Philadelphia, Pa., giving detailed information of the spring-hinge ruling pen; also of the Leader ruling pen.

The Lloyd water-tube boiler being put on the market by W. A. Lloyd, Ashtabula, Ohio, is well described in a 4-page folder just issued. Sectional drawings illustrate the type of boiler and complete the description.

A four page folder neatly printed in red and black describing and illustrating the Eclipse marine reducing valve is ready for distribution by the John Davis Co., 51-79 Michigan St., Chicago, Ill. A full description of the valve is given.

A full line of steam specialties is illustrated and described in a 64-page cloth bound catalogue issued by F. Hennebohle, South Chicago and Erie avenues, South Chicago, Ill. Many of these specialties are especially designed for marine work, and are such that every engineer will want to know of them.

The Stevenson automatic airtight door is thoroughly described and excellently illustrated in a 12-page folder printed on coated paper in two colors. These doors are especially adapted for refrigerating rooms and for any apparatus where fire-proof or smoke-tight doors are desired, and are manufactured by the Stevenson Co., Ltd., Chester, Pa.

Signal lamps of all kinds, as manufactured and sold by Russell & Watson, 145 Main street, Buffalo, N. Y., have much said regarding them in a 10-page folder recently issued. Several styles of lamps manufactured by this company are illustrated and considerable information is given regarding the patent fluted lenses which are the special feature of these lamps. Every marine man should send for a copy of this circular.

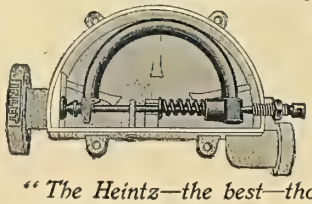
The Montauk multiphase electric cable is fully described in a 32-page book, 7 by 9 in. in size, with heavy cover. On nearly every page is a startling illustration of fire in some form or other, and much information is given showing the application of this cable to steamships and other uses for protection against fire. A copy of this book can be had by sending to the Montauk Multiphase Cable Co., 100 Broadway, New York.

One of the neatest catalogues we have received for some time is received from J. J. Ryan & Co., 68-74 West Monroe St., Chicago, Ill. It contains ten pictures illustrating the works of the company and some of the products. The works are believed to be the largest jobbing brass foundery in the country, if not in the world, and the pictures show that the company is prepared to turn out anything in the line of brass goods, anti-friction metal, bronze, etc. Everybody interested in the subject of brass goods should not fail to have a copy of this exceptionally handsome catalogue.

Labor or Steam

wasted in your plant? Suppose you had a hundred men on your pay roll, and fifteen to thirty doing nothing—"air punchers"—how long before you would weed them out? Yet, that's your proportion of loss in power when you run a plant without the "Heintz" Steam Trap.

Automatic, silent, economical, lasts a lifetime. Only six parts besides the case—can't wear out. No levers, floats, air valves or theories—just plain mechanics. Sent on thirty days' trial on request. Booklet "G" will finish the story. Want it?



William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

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REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.

Sturtevant patent steam hot blast apparatus is told about, with very choice illustrations and printing, in a 4 by 9 catalogue just issued. It is a beautiful specimen of typography, and, as the introduction says, "contains the essence of what they believe to be essential to a knowledge of the construction, advantages and patented features of the Sturtevant hot blast apparatus. The apparatus is made by the B. F. Sturtevant Co., Jamaica Plain, Mass.

An exceptionally fine catalogue containing 60 pages, 6 by 9 in. in size, is issued by G. M. Davis & Co., 100 North Clinton St., Chicago, Ill. It is unusually well printed, and there is an engraving on almost every page, the pictures being much above the average in quality. Many of the steam specialties therein described are designed especially for marine work, and many testimonials and much detailed information is given.

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

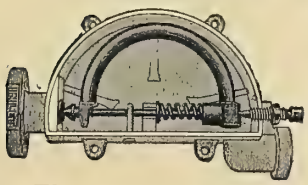
JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

Efficiency

makes the value of the "Heintz" Steam Trap—lots of others where you get more iron for your money—lots of imitations, too—and some of them look almost exactly like the "Heintz."

Every puff of steam you lose means a loss of more or less money-profits gone. Use the "Heintz" on your outlets, wherever steam escapes, and you will have an increased boiler capacity. We have saved some concerns large sums—more than we dare say. Can save you something, too.

The cost? Of little moment when traps are needed. Booklet "G" tells the starting point. Get one from us.



William S. Haines Company,

136 S. 4th St., Phila.

"The Heintz—the best—tho' it has imitators."

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Users of injectors and other steam specialties will want to send for a copy of the pocket-size catalogue just issued by the Hancock Inspirator Co., Watson St., Boston, Mass. It contains 32 closely printed and well illustrated pages devoted exclusively to the subject. It is a good business like catalogue.

Portable drills and other special tools manufactured by Thomas H. Dallett & Co., York street and Sedgley avenue, Philadelphia, Pa., are illustrated and described in a 40-page catalogue. Thes etools are particularly adapted to shipbuilders' uses, as they will drill in any direction and among any conditions. Further information can be had from the catalogue.

"Painting on Metal, with Specifications" is the appropriate name selected for a neat pocket book issued by Edward Smith & Co., paint manufacturers, 45 Broadway, New York. It consists of a technical discussion of the subject by A. H. Sabin, M.S., and a supplement containing many useful practical points about paints in general and the manufactures of the publishers in particular. This little book is really a creditable production, very different from the customary trade puff in leather covers. The author is an engineer and chemist of reputation, and he discusses the subject with an apparent knowledge and experience that attract the close attention of the interested reader. He is indeed an apostle of paint. In paragraph and page he reiterates the necessity for proper preparation of metallic surfaces before paint is applied, and goes into detail of the several processes: Sand blast, pickling, and scraping and brushing by hand. The book is profusely illustrated with engravings of various structures from railroad termini to stand pipes, to which the Smith paints have been applied.

BUSINESS NOTES.

PATENT SUSTAINED.—The Federal Circuit Court has handed down a decision in favor of the Hancock Inspirator Co., Watson street, Boston, Mass., regarding the Loftus patent ring valve which is used in many types of injectors.

MARINE ELECTRIC PLANT.—The contract for the electric plant on the new government coast survey steamer Pathfinder has been awarded to the E. G. Bernard Co., Troy, N. Y. This company has done considerable electrical work on government vessels and many well known yachts.

ROSS REGULATOR VALVE.—Attention is called to the cut of the regulator valve shown in the advertisement of the Ross Valve Mfg. Co., Troy, N. Y., in our advertising pages. This valve is especially designed for marine work and full information regarding its many qualities can be had from the company.

A BIG ORDER FOR PUMPS.—The Snow Steam Pump Works, Buffalo, N. Y., have received orders for the pumps to be installed on the vessels which the Cramp Shipbuilding Co. is building for the Russian Government. It is one of the largest orders placed for some time for pumps and is said to aggregate over $50,000.

A LARGE VENTILATING PLANT.—Four large electric fans having a combined capacity of 134,000 cubic ft. of air per minute have recently been set up in connection with the Boston Subway for the purpose of securing the necessary ventilation. They were designed, constructed and installed by the B. F. Sturtevant Co., Boston, Mass.

SHALLOW DRAUGHT STEAMER.—The Marine Iron Works, Clybourn and Southport avenues, Chicago, recently shipped a shallow draught steamer to the International Land & Colonization Co. in Mexico. The steamer is 58 ft. long, 11 ft. beam and draws 8 in. of water. She is designed to carry both freight and passengers. The boat was shipped to Mexico in sections, where she was put up.

A Fine Fishing Boat.—A fine boat has just been received by Captain Balzer, Rockaway Beach, L. I., 45 ft. long and 12 ft. beam, built by the Daimler Mfg. Co., Steinway, L. I., and equipped with Daimler motors. The boat will be used for fishing and pleasure parties.

A Marine Railway For Norway.—H. I. Crandall & Son, the well known firm of marine railway engineers of East Boston, Mass., have received an order from parties in Stavanger, Norway, for complete designs and working drawings for one of their improved marine railways to be built at that port.

Work In Brass, Bronze and Copper.—Many concerns doing work in brass, bronze and copper are in the market for special lines of goods in these metals, and attention is called to the advertisement elsewhere of the Standard Brass Works, Kalamazoo, Mich., which make a specialty of this line of work.

Enlarged Plant.—Owing to the great increase in business, the Norton Emery Wheel Co., Worcester, Mass., has built large additions to its establishment, and erected an 18 ft. kiln. With the new facilities the company will be in shape to fill promptly orders for anything in the line of emery wheels or grinders.

Tools For Navy Yards.—The Navy Department recently contracted for a considerable amount of machinery for the League Island Navy Yard, and awarded many thousand dollars' worth to the Niles Tool Works Co., Hamilton, Ohio. This company is a large builder of special appliances for shipbuilding.

Graphite Bushings.—Bushings and bearings especially where they are difficult to lubricate are offered by the Graphite Lubricating Co., Bound Brook, N. J. They are especially adapted for tackle blocks, steering gear, thrust bearings and in short any kind of a bearing where there is friction. Circulars and full information can be had upon application to the company.

Feed Water Heaters.—The Goubert Mfg. Co., 16 Church St., New York, is among the largest manufacturers in the country of feed water heaters, and during the past few months has installed many thousands of horse power of stationary work, one order alone calling for 35,000 horse power. This company also makes heaters for marine uses. Full information regarding them can be had upon application to the company.

Howden Hot Draft.—The Cleveland Shipbuilding Co., of Cleveland, Ohio, is pushing work on a 6,000 ton steamship which is to have 1,250 horse power. The purpose is to make her one of the most economical carriers on the lakes, and among other special appliances is the Howden hot draft, installed under the supervision of the Dry Dock Engine Works, Detroit, Mich.

Fulton Metallic Packing.—A metallic packing which engineers can carry in stock is the Fulton metallic packing which is backed up by very strong recommendation from Captain Du Bois, who has charge of the Erie Railroad floating equipment. Reference is made to this recommendation in the advertisement of J. L. Robertson & Sons, 218 Fulton street, New York, who are the manufacturers of this patent.

Seamless Drawn Tubing.—In his recent report regarding the U. S. Navy, Commodore George W. Melville stated "seamless drawn steel boiler tubes have been furnished during the year for all classes of our boilers with a degree of excellence undreamed of a few years ago." Practically all tubes of this kind furnished to the Government were supplied by the Shelby Steel Tube Co., Cleveland, Ohio. Much valuable information regarding high-grade tubes can be had by writing to the company.

Saved by the Anchor.—Captain Walter J. Thompson, of the steamer John H. Estill, under date of October 3, wrote as follows to the Baldt Anchor Co., Chester, Pa., from Savannah: "Yesterday we had a hurricane here, and I was anchored in the Savannah river six miles below the city, and used the anchor we ordered from you. The wind was blowing over sixty miles an hour ,and we only used the one anchor with 35 fathoms of chain, and it held us (we anchored in 4 1-2 fathoms of water). Vessels in the river dragged with two anchors and went ashore, while we only used one (the one we ordered from you). I think that speaks for itself. I would not have any other if I could get your make. My vessel is the steam pilot boat John H. Estill.

ENGINE FOR SALE.

An 8 inch, 12-inch, 16-inch and 24-inch by 18-inch stroke quadruple expansion Wells balanced engine for sale; in perfect condition.

FORE RIVER ENGINE CO.
Weymouth, Mass.

ELECTRICITY FOR MARINE ENGINEERS

Every intelligent engineer appreciates the fact that a working knowledge of electrical engineering has now become one of the conditions upon which many of the best positions depend.

Our Junior Course in Electrical Engineering meets this want. For our handsome illustrated **Free** book entitled **"Can I Become An Electrical Engineer?"** address

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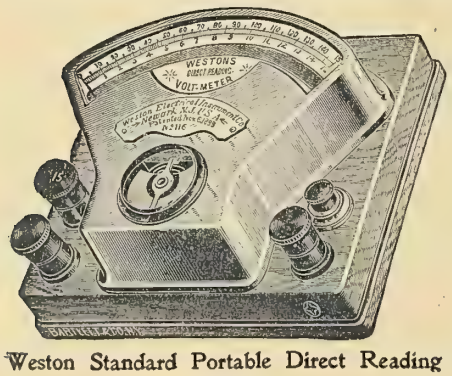

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AN ENGLISH ORDER.—The Newton Machine Tool Works, Philadelphia, Pa., have just received contract from John Brown, of Sheffield, England, who is the largest manufacturer of armor plate in the world, for a Special Double Radial Drilling Machine for drilling armor plate. They are also completing the drawings of a large cold saw cutting-off machine for the Armor Plate Works at Creusot, France. Mr. Charles C. Newton, of this company, has just returned from abroad, where he went on the special invitation of these firms, having in view the securing an order for these machines.

NOVEL MARINE ELECTRIC SET.—The Bullock Electric Mfg. Co., Cincinnati, Ohio, is getting out a new line of small generators, well adapted for small lighting plants for yachts and other craft. They are built either for high speed to be belt-driven or slow speed for direct connection. The company has lately put one of these small generators in the new steam launch for E. H. R. Green, president of the Texas Midland Railroad. This dynamo furnishes about sixty incandescent lights for the cabin and deck and one large search-light forward. The dynamo is operated by two Fairbanks, Morse & Co. gasoline engines, coupled together by means of a shaft. Two small engines were used as one large engine was not light enough, nor sufficiently compact. The dynamo is run by means of a belt from a solid disc fly-wheel between the engines. The dynamo is also fitted with a solid disc cast with pulley.

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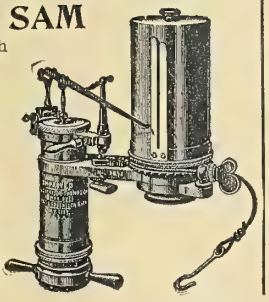

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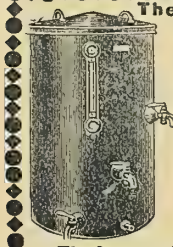

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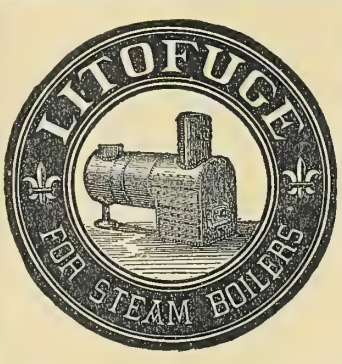

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Pumps and Condensers.—We are informed by the Deane Steam Pump Co., Holyoke, Mass., that the business of this company has been unusually good the past year. Orders for marine pumps have been exceptionally large and among the orders which they are now executing for this class of machinery is one for the City of Boston, and comprises air and circulating pumps, boiler feed pumps, boiler circulating pumps, also fire and bilge pumps for double screw ferryboat No. 3. The company is busy on three cylinder pumps and surface condensers; one of the largest sizes listed is to go to Southern Africa. Five of one size were recently shipped to Europe and one was furnished to the state police boat in Boston harbor.

The Dixon Products.—During the past summer the Joseph Dixon Crucible Co., Jersey City, N. J., has added an extension to its pencil factory, 40 by 90 ft., three stories high, where all machinery is driven by electric power. No expense has been spared in the equipment of this addition in the way of up-to-date elevators, furnaces, dry-rooms, etc. The Dixon Company's products go into every known field of industry; iron workers, brass workers, printing trades, stationers, cycle manufacturers, hat manufacturers, etc.

Boats For Steam Yachts.—J. G. Cassatt, of Philadelphia, owner of the ocean-going steam yacht Eugenia now being built at the Roach shipyard, at Chester, Pa., from designs of Gardner & Cox, of New York, has ordered from the Spalding St. Lawrence Boat Co., of Ogdensburg, N. Y., a set of boats to carry at the davits, viz.: a handsome sailing lifeboat, 18 ft. long; one 12 ft. dinghey, and one 18 ft. cutter, all to be of mahogany throughout. This company also has orders for boats for Eugene Tompkin's new yacht, as well as for Richard Stephen's. All the boats will be finished in mahogany and be fine samples of the boat builders' art.

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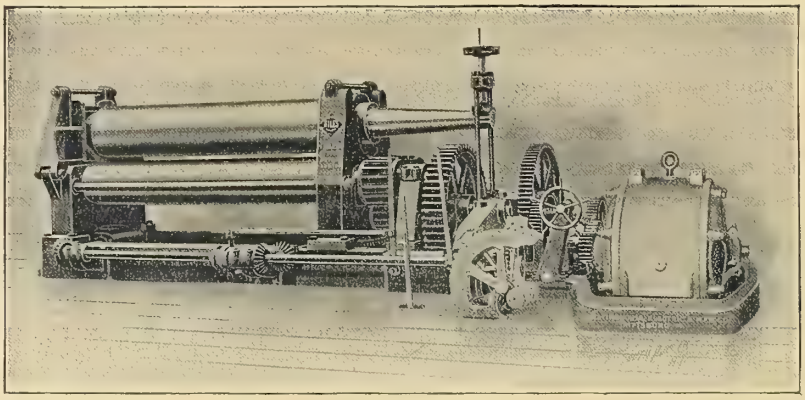

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MARINE WATER-TUBE BOILERS.—The Stirling Water Tube Boiler Co., Pullman Building, Chicago, Ill., has perfected arrangements to go extensively into the business of building water-tube boilers designed especially for marine work. In order to supply boilers of any capacity the company has secured the American rights to be exclusive builders of the Niclausse and Yarrow boilers and arrangements have also been perfected to manufacture the Mosher boiler. The company is one of the largest establishments in the United States designed especially to build water-tube boilers, giving it ample facilities to fill any order at short notice.

GOOD STEAMING RECORD.—Captain M. De Puy, 19 South street, New York, inventor of the Paragon boiler, has received the following very highly complimentary letter: We, George E. Noyes and Nicholas W. Godfrey, are owners of the new steam canal boat Paragon, purchased from Captain M. De Puy, which has been run by us eighteen days on only thirteen tons of coal. The boiler lies over any marine boiler we have ever owned, seen or heard of. It is actually doing its work on half the fuel burned by our steamer Silex, which is of the same dimensions as the steamer Paragon. Therefore, it is apparent that the Paragon boiler will save to us in fuel bills from $800 to $1,000 annually, or at least $8,000 in ten years." The Paragon recently made a trip down the Hudson river towing ten canal boats fully laden with a small consumption of coal, very astonishing to canal boatmen. Full information regarding this trip and the boiler can be had from Captain De Puy.

MARINE PRESSURE REGULATOR.—The No. 5 pressure regulator for marine service, which is being put on the market by G. M. Davis & Co., 100 North Clinton street, Chicago, Ill., is designed especially for steamship service. It is claimed to reduce from any initial pressure to any working pressure desired and to regulate successfully where a high, true pressure is desired.

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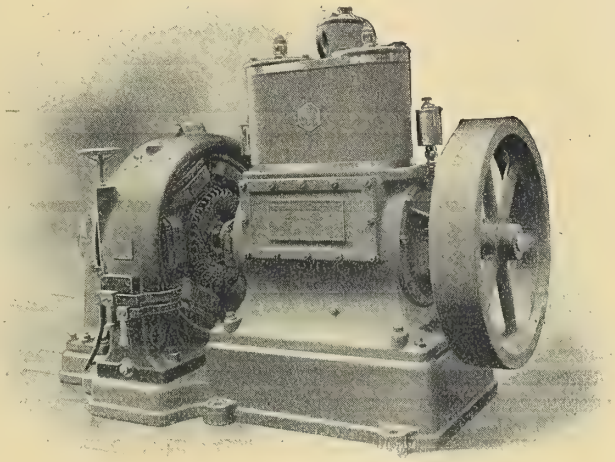

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